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A production control procedure for possible use in Naval Shore Establishments based upon a study of the production control division at the Naval Ordnance Plant Indianapolis.

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Marks

Production control procedure for possible use in Naval Shore Establishments based upon a study of the production control.

A PRODUCTION CONTROL PROCEDURE FOR POSSIBLE USE IN NAVAL SHORE ESTABLISHMENTS BASED UPON A STUDY OF THE PRODUCTION CONTROL DIVISION AT THE NAVAL ORDNANCE PLANT INDIANAPOLIS

A Thesis

Submitted to the Faculty

of

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by

David A. Marks

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science in Industrial Engineering

June, 1950

ACKNOWLEDGMENT

The majority of the principles expounded herein have been the natural result of numerous conferences with people engaged in Production Control today integrated with the concepts of production control as taught in current academic courses. It is indeed proper that this acknowledgement be made to give credit, where appropriate, for the data obtained.

To Captain A. D. Blackledge, Commanding Officer, Naval Ordnance Plant, Indianapolis; to Mr. D. D. Dennis, Head of the Production Control Division; and to the staff of the Plant, whose sincere and extremely helpful cooperation greatly aided the investigation, the author wishes to express his deepest gratitude.

Profound appreciation is extended to Professor Halsey F. Owen, of the Industrial Engineering Department, Purdue University, for his excellent guidance throughout the study.

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ABSTRACT

The problem of this study is to recommend a production control procedure for possible use in various Naval Shore Establishments.

The data upon which the recommended procedure is based was gathered from the Production Control Division, Naval Ordnance Plant, Indianapolis, Indiana. The functions of the recommended production control procedure were drawn from the texts listed in the Bibliography.

With the exception of the major changes in the production control procedure necessitated by a variation in the type of manufacture, the production control procedure used by the Naval Ordnance Plant, Indianapolis, Indiana, may be adapted for use in various Naval Shore Establishments. The recommended production control procedure includes the functions of material control, routing, scheduling, dispatching, and the determination of labor requirements.

ABSTRACT

A PRODUCTION CONTROL PROCEDURE FOR POSSIBLE USE IN NAVAL SHORE ESTABLISHMENTS BASED UPON A STUDY OF THE PRODUCTION CONTROL DIVISION AT THE NAVAL ORDNANCE PLANT INDIANAPOLIS

INTRODUCTION

The problems that arise in the Production Control Division of A Naval Shore Establishment may be different, in many cases, from those that occur in the Production Control Division of civilian industrial plants. It is with these possible differences in mind that this study was undertaken. It is felt that there is a definite need for such a study in order to help the military establishments keep abreast of the latest developments in production control and in the management field. Another aspect of such a study is that it may help to bring about further economy which is mandatory on the part of the military in peace time. Another and by no means less important aspect of such a study is that it may provide a functional structure upon which an existing Production Control Division could be reorganized, or which could be used in the expansion program during a national emergency.

Previously accomplished work which is related to the problem was done by Lieutenant Colonel Robert W. Breaks, U.S.A., in his thesis, "An Appraisal of the Production Control Methods Used at Government Arsenals," June, 1947. This thesis dealt primarily with the production control methods applicable to chemical manufacturing processes.

The majority of the information upon which the present study is based was obtained at the Naval Ordnance Plant, Indianapolis, Indiana, which is sometimes abbreviated in this paper as NOPI. The information was obtained by means of conferences with each responsible individual in the Production Control Division. These conferences resulted in the

A PROCESS-ORIENTED INVESTIGATION INTO FUTURE FOR IN-SERVICE TEACHER EDUCATIONALISTS BASED UPON A STUDY OF THE PROFESSIONAL DEVELOPMENT MODELING OF THE SOUTH CAROLINA SCIENCE EDUCATIONALISTS

INTRODUCTION

The problem that arises in the professional training of a level being distinctiveness may be different, in many ways, from that that occurs in the Productive General Training of skilled industrial plants. It is with these possible differences in mind that this study was undertaken. It is felt that there is a definite need for more research. It is felt that there is a definite need for more research about in order to help the military establishments keep abreast of the latest developments in personnel management and in the management field. Another aspect of such a study is that it may help to avoid some pitfalls which is encountered on the part of the military in place-ing. Instead and by no means less important aspect of such a study is that it may provide a theoretical structure upon which an existing inventory training model would be constructed, or which would be used in the recruitment process during a national emergency.

Previously mentioned work which is related to the problem was done by Lieutenant Colonel Robert T. Brown, U. S. A., in his thesis, "An Appraisal of the Production Control Method Used at Operational Ar-senals," June, 1957. This thesis dealt primarily with the production control function applicable to industrial manufacturing processes.

The majority of the information upon which the present study is based was obtained in the Naval Ordnance Plant, Indianapolis, Indiana, which is essentially equivalent to this paper as well. The information was obtained by means of questionnaire and personnel interviews in the Preservation Control Division. These questionnaires consisted of

obtaining of forms and charts pertaining to a particular unit along with sufficient information about the functions of that unit to describe in general the unit's responsibilities and its place in the organizational structure of the production control division. Using this information as a basis for investigation, this study was compiled by considering the prime functions of each unit and how these functions would apply to the problems of the production control divisions of various Naval Shore Establishments.

Production Control may be defined as the mental and physical techniques applied in such a way that the right quantity and quality of a product will be produced at the right time by the best and cheapest methods. This definition appears widely in the literature on the subject of production control; its interpretation, however, has extremely broad scope. Based upon the collective opinion expressed in the first six texts in the Bibliography, the major emphasis placed on the interpretation of the definition of production control includes the functions of (1) material control, (2) routing, (3) scheduling, (4) dispatching, and (5) labor requirements.

THE NAVAL ORDNANCE PLANT, INDIANAPOLIS, INDIANA

The History, Organization, and Physical Properties of the U. S. Naval Ordnance Plant, Indianapolis, Indiana

This plant was designed, constructed, and staffed by a civilian engineering company during World War II for the purpose of manufacturing the Norden bombsight and related equipment, and aircraft lead-computing gunsight systems; some sixty thousand fire control instruments were manufactured during World War II.

Late in 1945, the plant was taken over by the Navy. It is now being run under the cognizance of the Bureau of Ordnance, Navy Department. As a Naval Shore Establishment, the plant has the following functions:

(1) research in, and engineering development of, aviation fire control equipment;

(2) the manufacture of that equipment;

(3) the manufacture of line maintenance stores;

(4) the overhaul, modification, and modernization of fire control instruments, including radar attachments and their accessories.

The present staff of the plant consists of the original employees who were inducted into the Civil Service system at the time of conversion to naval control. Assigned to the plant are 11 naval officers and 5 enlisted men, and 1 Marine officer and 40 enlisted men. These officers and men serve in the following capacities at the plant: as Commanding Officer and Executive Officer, and in the Budget Office, the Security Division, the Safety Office, the Communications Office, the Supply and Fiscal Department, and the Medical Department.

The Naval Ordnance Plant, Indianapolis, Indiana

The Navy's Ammunition Plant, Indianapolis, Indiana

This plant was designed, constructed, and staffed in a relatively remarkable compact period during World War II for the sole purpose of manufacturing the heavy industrial and metallurgical equipment, and delicate instrumentation quantity equipment some only thousand fifty ancient instruments into nonexpensive service World War II.

Late in 1940, the plant was taken over by the Navy. It is the belief you might the magnitude of the Navy's of ordnance. Thus constructed in a total thirty installations, the plant has the principal functions:

(1) manufacture is, and maintenance development-of, military fire control equipment;

(2) the manufacture of that equipment

(3) the manufacture of like mechanisms manual

(4) the overhaul, modification, and maintenance of fire control instruments, including naval ordnance and their accessories.

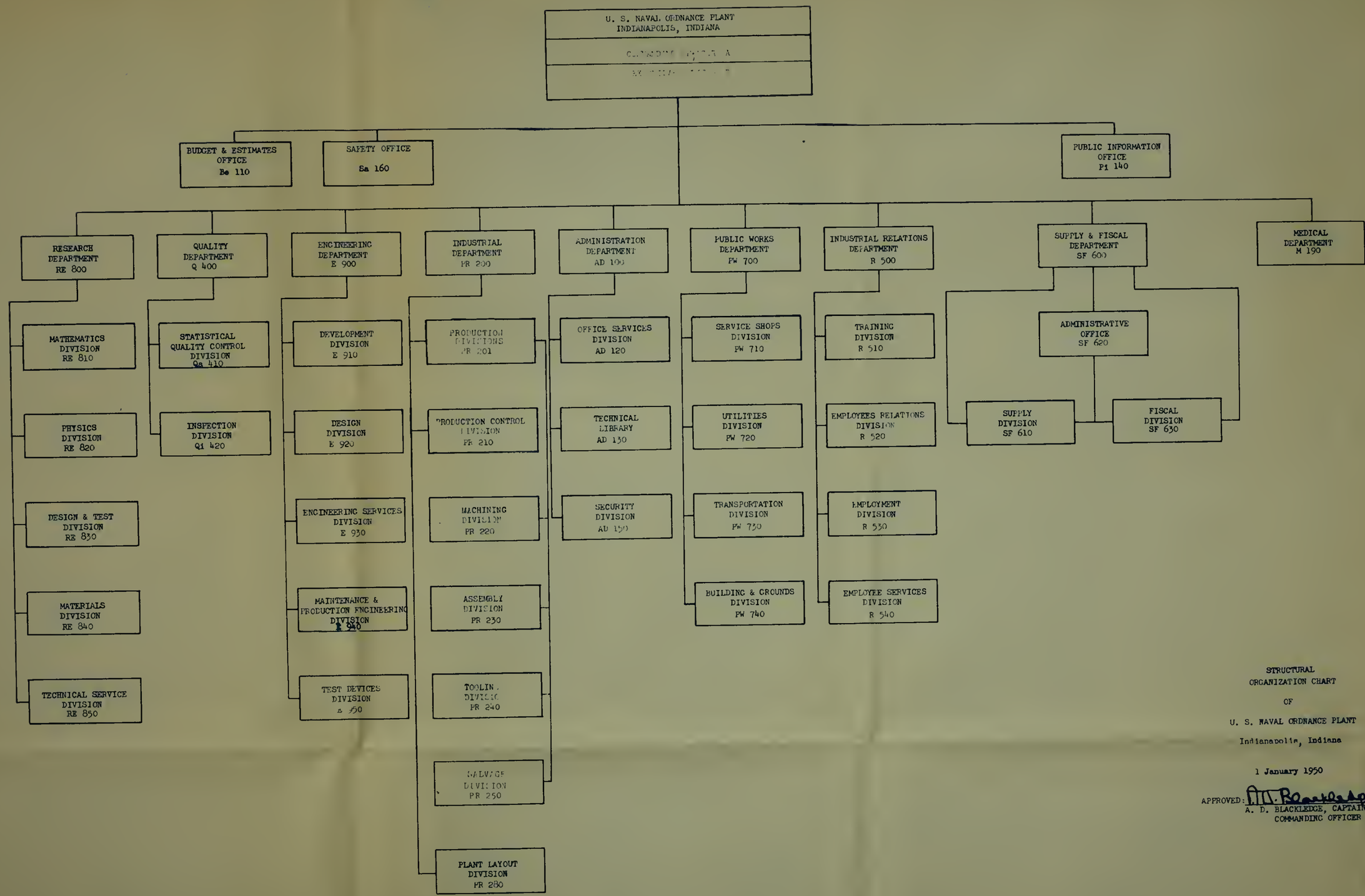
The present staff of the plant consists of the original employees who were transferred from the Civil Service system at the time of activation to naval control. Employed in the plant are 13 naval officers and 2 military men, and 1 Marine officer and 40 military men. There are three old men among in the training supervisors in the plant. In managing officer and deputy officer, and in the Public Office, the security division, the safety office, the industrial office, the supply and fiscal department, and the medical department.

Organized under the direction of the Commanding Officer with the assistance of the Executive Officer, the plant has nine departments. These departments are divided into divisions composed of sections, which are in turn subdivided into units. A structural organization chart of the plant at the divisional level appears in Figure 1.

Located in northeastern Indianapolis, Indiana, the plant occupies some one-hundred-sixty acres of land. Its main structure, the manufacturing building, is nine-hundred-twenty feet long and five-hundred-sixty feet wide, covering eleven and a half acres of floor space. The plant facilities are of the most modern type, including an air-conditioning system affording constant temperature and controlled humidity, with six complete changes of inside air cleared through an electrostatic filter in one hour. Heat is supplied by two oil-burning steam boilers. The lighting system employs both direct and indirect facilities, and maintains a one-hundred foot candle intensity at the work stations. These modern facilities afford to the plant's staff the maximum in comfort and ideal working conditions.

Imagine an open-air theatre of the Greek or Roman type with the seat-backs of the theatre lifted, the plant box also inverted. These hopperboxes are filled with [illegible] of soil, which can be kept moistened with water. A structural cross-section shows the place of the different layers showing in Figure 1.

Instead of surrounded Continental Seating, the plant hopper same cross-sectional area of land. In this case vegetation, the [illegible] building, is also [illegible] that land and [illegible] the plant facilities are of the same modern type. Inserting an air-conditioning system affording constant temperature and humidity, with the [illegible] changes of fresh air [illegible] [illegible] [illegible] is now [illegible]. Heat is supplied by the [illegible] [illegible] below. The lighting system employs [illegible] and [illegible] [illegible], and [illegible] a [illegible] that [illegible] is the [illegible] [illegible] [illegible]. These [illegible] [illegible] in the [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] and [illegible] [illegible].



STRUCTURAL
ORGANIZATION CHART
OF
U. S. NAVAL ORDNANCE PLANT
Indianapolis, Indiana

1 January 1950

APPROVED: A. D. Blackledge
A. D. BLACKLEDGE, CAPTAIN, USN
COMMANDING OFFICER

The Nature of the Product

The product of the plant is aviation fire control systems, engineered and manufactured to meet service performance requirements and specifications. The mathematical expressions for the solution of various fire control situations are mechanized to a fine degree of accuracy. Mechanical and electronic methods translate the theoretical principles into useable systems.

A component unit of a fire control system is, in reality, a precision instrument. The exactness in the manufacture of a unit's individual parts is comparable to that employed by the most skilled toolmakers in industry.

There is a great variety of products among the aviation fire control systems. Thus, the system which is installed in a fighter to control the fire of its guns is vastly different from that installed in a high-altitude bomber to control the dropping of its bombs. The addition of controls for torpedoes, rockets, and air-launched guided missiles further increases the dissimilarity between the fire control systems.

The product of the plant is, therefore, precision instruments possessing little uniformity among themselves.

The Science of the Process

The problem of the plant is activated flow measurement, implemented and monitored on some advanced particulate engineering and specialisations. The mathematical expressions for the motion of various flow control elements are mentioned in a flow diagram of measurement. Electronical and electronic methods involve innovational principles into simple systems.

A improved tool of a flow control system is, in reality, a physical instrument. The measurement is the manifestation of a multi'a individual parts is comparable to that required by the most critical measurement in industry.

There is a great variety of problems about the existing flow control systems. Thus, the system which is installed in a digital to control the flow of the gas is mainly difficult than most installations is a high-utilisation number to control the supplying of its tender. The substitute of material for instance, resource, and air-lowered digital sizes values further increases the flexibility between the flow measurement as above.

The product of the plant is, therefore, controlled instrument measuring flow within mainly using electronics.

The Problem of Production Control

The plant is engaged in a combination of the job shop and intermittent types of manufacture. This type of manufacture is characterized by the production of special orders and of a great variety of products in limited quantities. In a year's time, the plant may receive three-hundred special orders which will require the production of one-hundred-thousand different items in average quantities of twenty-five units per item.

Some of the factors which necessitate a complex production control system are:

1. Number of ultimate parts in the product.
2. Number of different operations on each part.
3. Extent to which processes are dependent, i.e., those which cannot be performed until previous operations have been completed.
4. Variation in capacity of machines for different classes of work. In many industries speed of machines varies according to the nature of the material being worked on.
5. Degree to which subassembly exists.
6. Degree to which customers' orders with specific delivery dates occur.
7. Receipt of orders for many small lots.[1]

The fact that the product, aviation fire control equipment, is comprised of precision instruments having large variety among themselves accentuates the factors listed above.

The machine tools in the plant are of the general purpose type. On the whole, there is a surplus of machine tools. The special nature and complexity of the finished product necessitates the designing of special testing equipment. Normally, available commercial test equipment is modified to meet the plant's special needs. In some cases,

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[1] Alford, L. P., Bangs, John R., Production Handbook, The Ronald Press Company, New York, N. Y., 1944, pp. 75.

The Problem of Production Control

The plant is engaged in a combination of job-lot and in-
dustrial types of manufacture. This form of manufacture is adopted
but not by the production of special orders and of a great variety of
products in limited quantities. In a plant's case, the plant has many
time-consuming jobs which orders which will require the construction of con-
tingency-increasing difficulty times in arranging quantities of manufactur-
ing jobs time.

Some of the reasons which necessitate a complex production
control system are:

1. Number of different parts in the product.
2. Number of different operations on each part.
3. Orders in which operations are performed. Lots, shop
   order cannot be performed until previous operations
   have been completed.
4. Variation in capacity of machines for different kinds
   of work. In most industries, speed of machines
   varies according to the nature of the material being
   worked on.
5. Jobs in which necessarily delay.
6. Jobs in which machines' orders with capacities dur-
   ing busy times to use.
7. Number of jobs that keep small lots.[1]

The fact that the product, material flow industrial equipment,
is acquired or installed between several months large variety among other
factors determine the factors listed above.

The machine tools in the plant are of the general purpose
type. In the shop, there is a number of machine tools. The typical
machine and capacity of the finished product determine the finish-
ing of special varying equipment. Normally, multiple commercial lathe
equipment is utilized in many the plant's special needs. In some cases,

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[1] Lipman, R. W., Jones, Alan H., Production Handbook, The Ronald Press
Company, New York, N. Y., 1944, pp. 75.

however, test equipment must be designed from basic fundamentals.

The employees in the Machining and Assembly Divisions are skilled craftsmen. Each machinist is capable of operating several types of machine tools. The Assembly Division employees are, in many cases, qualified machine operators; and the machinists, in turn, are capable of doing assembly work. Thus, when the plant is overloaded with machine tool work, the Assembly Division employees can be transferred to the Machining Division. The control of such inter-division personnel is a function of the Production Control Division.

To summarize, the nature of the product, the special equipment required in its manufacture, and the skilled staff of the plant present complex problems which must be solved by the Production Control Division.

The Production Control Division

The Organization of the Production Control Division.

The Production Control Division, one of six divisions comprising the Industrial Department, consists of three sections, the Planning, Methods, and Progress Sections. Each of these is divided into various units. The organization chart of the Industrial Department, including the unit breakdown, appears in Figure 2.

The Responsibilities of the Production Control Division.

The Production Control Division plans and directs the scheduling of production activities; provides materials, tools, and specific manufacturing instructions for the operating shops; maintains daily floor checks to eliminate delays and work stoppages; moves stores and disposes of all manufactured items; is the source of all data on production performance, current and anticipated plant productive load, estimated productive and non-productive expenditures, current budget status of productive projects and the Industrial Department's maintenance allocations; acts in an advisory capacity in the matter of employment level and confers with the Engineering Department in the matter of product design for economical manufacture.

The responsibilities of the sections of the Production Control Division are as follows:

The Planning Section is charged with the responsibility of both long range and specific project planning and scheduling; the ordering of raw materials and purchased parts; the issuance of shop order kits; the preparation of charts and graphs indicating production performance trends, and other statistical production data; the compilation and reporting of production costs to provide comparison between the

The Production Control Division

The Organization of the Production Control Division.

The Production Control Division, one of the divisions responsible for the industrial engineering, consists of three sections, the Planning Section, and Planning Section. Each of them is headed by a chief. The organization chart of the Industrial Engineering, including the work Measurement Section is Figure 8.

The Responsibilities of the Production Control Division.

The Production Control Division plays the planning the scheduling of production activities; provides manufacturing, tools and equipment information for the operating account including daily time sheets to administrative staff and management; serves the interests of all manufacturing labour in the course of all jobs in production process; controls, assigns and maintains plant activities including production and non-productive activities, assigns budget status of factory facilities projects and the industrial engineering's maintenance allocation; acts in an advisory capacity in the matter of indirect labor and works with the Engineering Department in the matter of product design for economical manufacture.

The responsibilities of the members of the Production Control Division are as follows:

The planning section is charged with the responsibility of both long range and specific product planning and maintaining the schedule of new materials and personnel, assist the Department of such means with the production of master and factory instructing production personnel limits, and labor availability provision exist the availability and involving of production work by parallel accounting between the

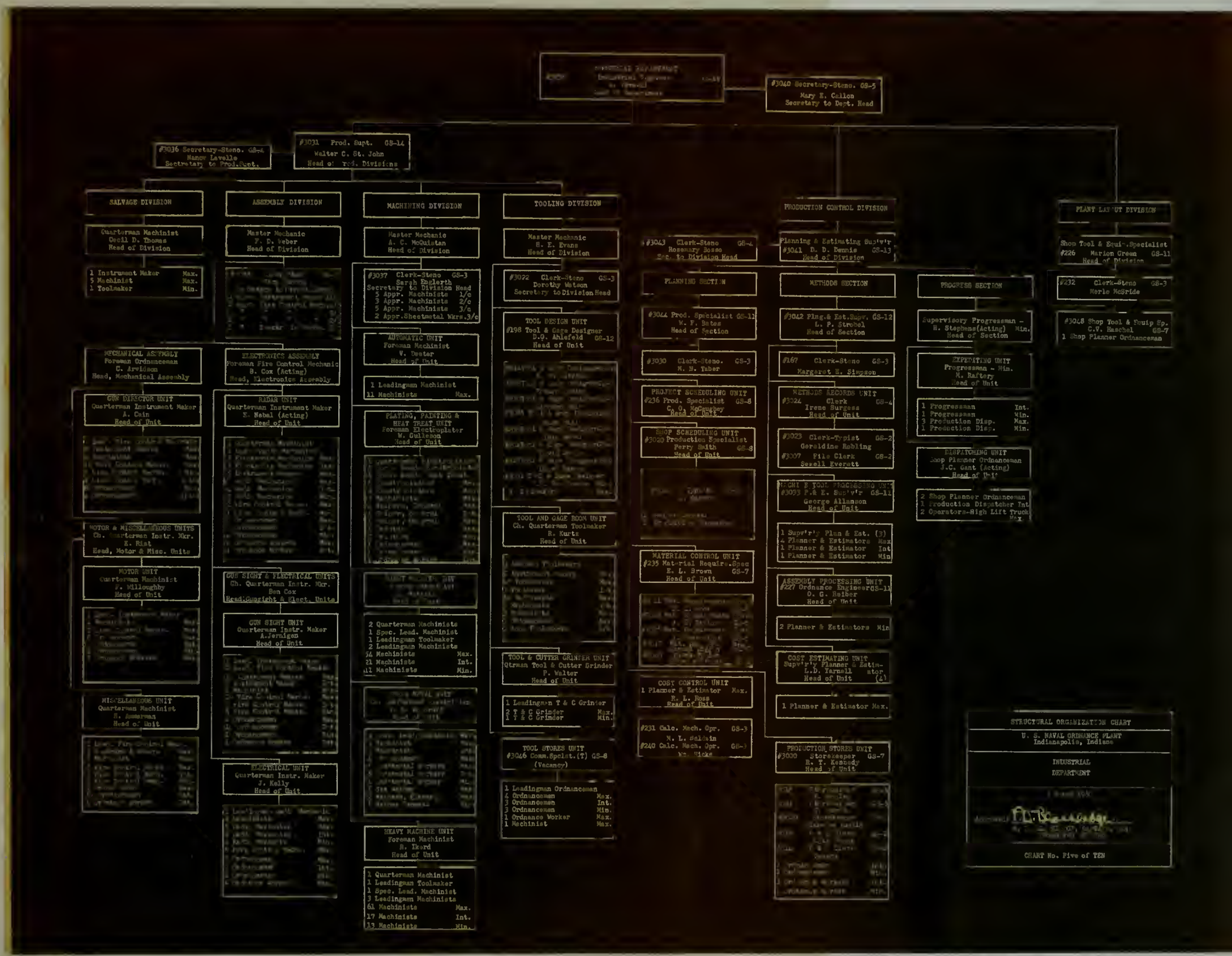


Fig. 2 Organization Chart of Industrial Department

original estimate and the actual expenditure; and the control of project expenditures.

The Methods Section is responsible for cost estimation for the proposed production work; the preparation of detailed process routing sheets (operation sheets) for component parts, sub-assemblies, finished units, and the necessary time to perform such operations; the ordering of all special tools and gages; the designing and ordering of special test equipment; conferring with the Engineering Department regarding changes of design which will facilitate production and lower costs; the receipt, recording, and distribution of engineering information to the Industrial Department; the advising of the Plant Layout Division regarding the placement of machine tool equipment; and the recommendation of procurement of specialized machine tool equipment and accessories.

The Progress Section is charged with the responsibility of distributing the shop order kits; insuring the completion of scheduled work on time; expediting the procurement of raw materials, tools, gages, and purchased parts; conferring with the various departments regarding solutions of production "bottlenecks;" reporting weekly the production status of projects; and the inter-divisional handling of materials.

The Handling of a Proposal

The Bureau of Ordnance, before allocating funds or authorizing a plant to begin work on a project, requires each plant interested in bidding on the work to submit an estimate or proposal as to the expected delivery date of the first completed item and the approximate cost of the project. Generally in letter form, the Bureau's request for this estimate is accompanied by rough prints and parts lists pertaining to the product, or by a word description of the product.

This letter is received and processed by the Budget Office of the plant administration. The Proposal or Cost Estimation and Scheduling Form (blue), Figure 3, is originated in that office and accompanies the prints to the Engineering Department, where they are examined for the purpose of estimating an engineering release date. This date is then entered on the proposal.

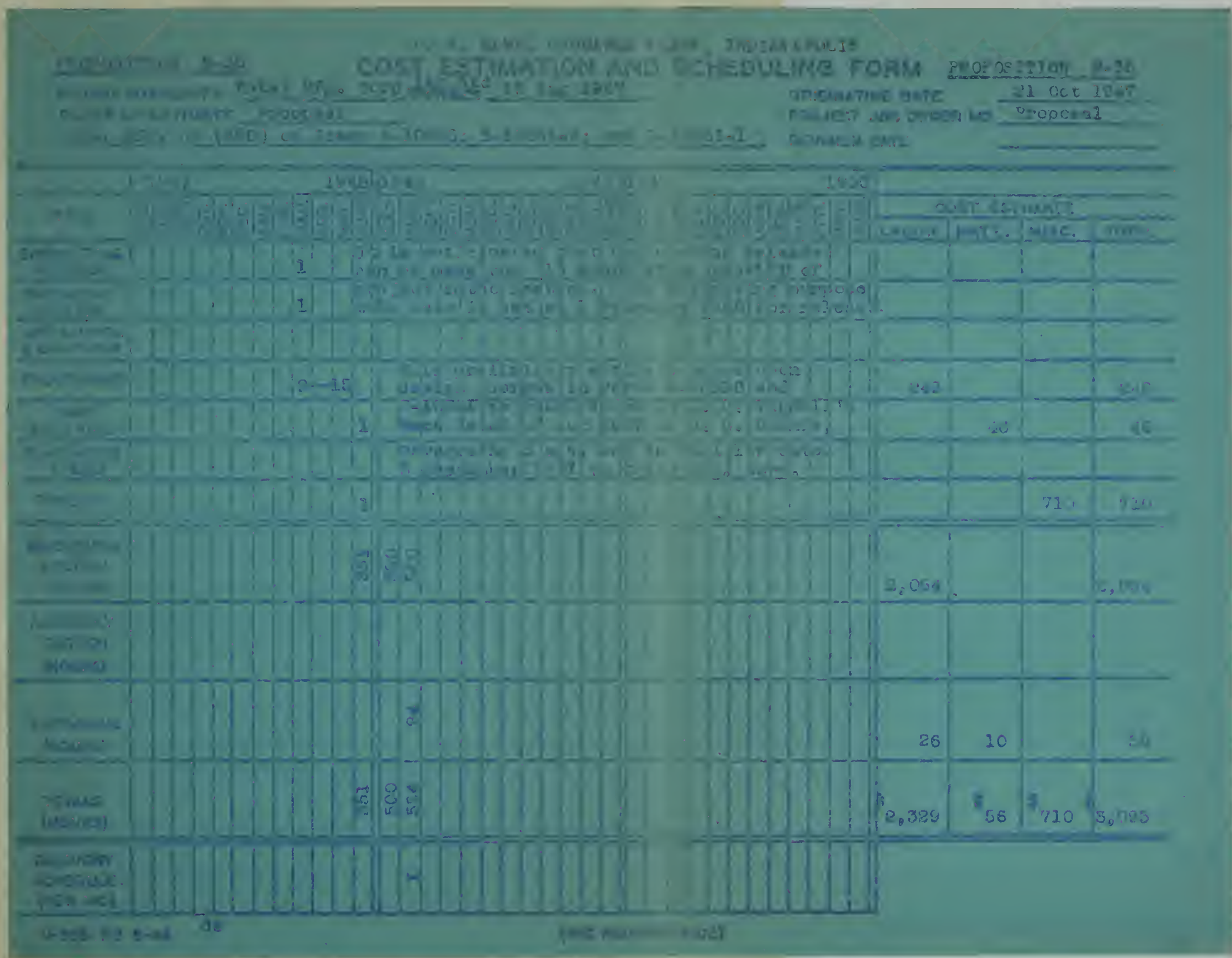
From the Engineering Department the proposal and attachments then go to the Cost Estimating Unit of the Production Control Department, where all the remaining estimates, with the exception of the delivery schedule, are made. The Cost Estimating Unit fills in the cost estimate columns of the proposal in terms of dollars only. The method used to arrive at these estimates will be described later in a section on this unit.

When the above cost estimation is complete, the proposal is then returned to the Project Scheduling Unit, where an estimate is made as to where in the work load the project can be placed, when delivery on the finished products can be expected, and in what quantity they can be completed during each period until the project's termination.

The proposal and its accompanying papers are then returned to

The Building of a Treasure

The Queen is expected, before attempting their to determine that a place to begin work on a project, Thailand must first [illegible] in making an [illegible] to [illegible] in the [illegible] [illegible] [illegible]



COST ESTIMATION AND SCHEDULING FORM

ORIGINATING DATE 21 Oct 1947

PROJECT AND ORDER NO Proposal

COST ESTIMATE

LABOR	MAT'L.	MISC.	TOTAL
242			242
	46		46
		710	710
2,054			2,054
26	10		36
$2,329	$56	$710	$3,095

Fig. 3 Cost Estimation and Scheduling Form

the Budget Office for final review, issuance, and submission to the applicable activity.

These estimations and information are presented in general form and are regarded as a tentative commitment by the plant. They serve as a broad basis for planning by the Bureau of Ordnance, for cost estimation and approximate delivery schedules.

The Handling of a Firm Estimate

When the Bureau of Ordnance has decided to authorize the plant to begin work on a project and has allocated the necessary funds, this authority and allocation come to the plant in the form of a project order number and an allotment number. These are received by the Budget Office and are processed in the same manner as was the information pertaining to a proposal.

The Firm Estimate or the Cost Estimation and Scheduling Form (white), Figure 4, is originated by the Budget Office and differs from the proposal only in color and the amount of information thereon. This form and current pertinent information, which may include more detailed prints and, or parts lists, are forwarded to the Engineering Department. The Engineering Department proceeds as expeditiously as possible with the work of originating production engineering releases without awaiting a formal job order. This precludes delay of the engineering release because of delay in issuing a job order. If the firm estimate is accompanied by a word description only, the Engineering Department develops the prints and parts lists. A revised engineering release date is made in greater detail than in the case of the proposal.

The originated or revised prints and parts lists are sent to the Methods Records Unit, who transmits a copy to the Material Control Unit. The Material Control Unit uses the information from the parts lists to determine whether the parts can be obtained from the Supply system or whether they will have to be procured in another manner.

This information, together with the firm estimate, is then passed to the Cost Estimating Unit. Using the information furnished by Budget, Engineering, and Supply, and their own internal work forms, the

The Possibility of a Plan Failure

Thus the reason of Congress has decided to eliminate the plans in their entirety and has attempted the [illegible] Plan. This additionally has attributed [illegible] to the point of [illegible] [illegible] Plan. These are [illegible] by the Congress [illegible] and are permanent in the same manner as was the information pertaining to a proposal.

The plan [illegible] by the Core Architecture and [illegible] Plan (Active), Figure 4, is originated by the Budget Office and directly from the proposal only in color and the number of information [illegible]. This [illegible] and current particular information, which may [illegible] some [illegible] plans and, or parts thereof, are [illegible] to the Contracting Department. The Contracting Department proceeds as expeditiously as possible with the work of [illegible] procedures [illegible] [illegible] and a formal job order. This [illegible] Order of the [illegible] [illegible] of doing in [illegible] a job order. If the plan [illegible] is [illegible] by a [illegible] [illegible], the Contracting Department [illegible] the plans and parts Plans. A [illegible] [illegible] [illegible] is [illegible] [illegible] the [illegible] of the proposal.

The [illegible] or [illegible] plans and parts lists are [illegible] the Contract Department [illegible], [illegible] a [illegible] in the [illegible] Contract Plan. The [illegible] [illegible] [illegible] [illegible] lists to [illegible] [illegible] [illegible] [illegible]

U. S. NAVAL ORDNANCE PLANT — INDIANAPOLIS

COST ESTIMATION AND SCHEDULING FORM

PROJECT ORDER NO. 60818-Ord DATES 6 30-50 ORIGINATING DATE 20 Jan 1950
CLASS OF ESTIMATE JOB ORDER NO. 60818-757
TASK: Misc. Items of Standard Hardware & Tools REVISION DATE - -
for 400 Cycle Synchros Classification: MFG-APA

ITEM	1949 JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	1950 JAN.	FEB.	MAR.	APR.	MAY	JUNE	1950 JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	1951 JAN.	FEB.	MAR.	APR.	MAY	JUNE	1951 JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	COST ESTIMATE LABOR	MAT'L	MISC.	TOTAL
ENGINEERING RELEASE							4																											
PACKAGING RELEASE							16																											
DRAWINGS & CASTINGS																																		
PURCHASING																																		
SHOP DETAIL									15																							1678		1,678
PURCHASED TOOLS										15																						50		50
TOOLING										15																					1,495	150		1,645
MACHINING (SECTION HOURS)										1000	4000	1834																			11,877			11,877
ASSEMBLY (SECTION HOURS)												443																			739			739
MANAGING (HOURS)												100																			235	350		585
TOTALS (HOURS)										1000	4000	2377																			$14,349	$2228		$16,574
DELIVERY SCHEDULE (PER MO.)										X	X																				Appropriation: 1780702-O&OS-Navy-1949			
																															Expenditure Account: 62472-Item 1 thru 15; 29073 - Item #16			

BND-GL, 3-1-49 B-60, 000

Fig. 4 Cost Estimation and Scheduling Form

Cost Estimating Unit makes an accurate estimate of the costs that will be incurred in the process of manufacturing a complete project. This estimate is made as a result of more meticulous investigation than was afforded the proposal.

The Firm Estimate is then returned to the Project Scheduling Unit for processing similar, with a few exceptions, to that given the proposal. As well as estimating the delivery schedule, this unit breaks down each cost figure into man-hours and loads the firm order by months. Consideration is given to the total available man-hour capacity of the plant and to the already existing load when the loading of a new project is undertaken.

The completed Firm Estimate is then returned to the Budget Office for final review, issuance, and submission to the applicable activity.

As was noted in this discussion, the estimates and information presented are the result of extended investigation and are considered a definite commitment by the plant, since they are specific information pertaining to the Bureau's planning regarding costs and scheduled delivery dates.

The firm Cost Estimation and Scheduling form for a project actuates the flow of work in the Production Control Division. There is a great exchange of information between units which, if included in a general flow diagram, would become confusing, defeating the diagram's general purpose of giving an over-all picture of the work flow in the Production Control Division. Only the general pattern of the work flow is indicated and only the more important forms mentioned in the description of the functions of the various units. The following diagram shows

Jose Ortiz-Haven (OH) turns an adaptive analysis of the series flow will be learned in the process of establishing a complex project. This analysis is done as a result of some preliminary investigation done and affordes the projects.

The firm designs is also attached in the project consulting fees for professional clients, with a fee structure, so look after the proposal. As well as establishing the delivery schedule, this only issues done such area (Jiaxe lake sub-house and local the flow sites by months. Consultation is given in the total available management expenditure at the plant and in the already existing land when the location of a new project is underdeveloped.

The municipal planning is also attached to the budget office for first phase, landowner, and administration in the application activity.

In the final it also discussion, the validation and interpretation procedure are the result of extended development and now established a satisfies consultant by the plant, which has the specific information participating in the business's planning regulating stage and expanded development stage.

The firm does instructions and consulting flow for a project adjusting the flow of work in the procedures special training. There is a great resource of information between units units, if location is a general flow diagram, small house analysis, following the diagram's general purpose of giving an overall picture of the work flow in the Production Control Division. Only the general problem of the main view is initiated and only the main important flows monitoring in the development of the procedures of the building units. The initial diagram shows

The Project Scheduling Unit

The Project Scheduling Unit plans the over-all plant schedule, issues the internal scheduling for the Production Divisions, and compiles certain important production statistics which aid in formulating the plant's labor requirements.

The following forms are originated in the Project Scheduling Unit: The Internal Schedule Form, shown in Figure 5, indicates the required completion dates of a project. The information contained in this form is taken from the Cost Estimation and Scheduling Form, and is distributed throughout the plant. Each division advises the Unit as it completes its portion of the project, thus furnishing the Unit with an accurate record of the status of each project.

The Forecast of Productive Labor, Figure 6, is a chart which displays the over-all plant production forecast in terms of man-hours, projected eighteen months ahead. The data is divided into program numbers, and represents the load on the various departments. The main function of this chart is to determine the amount of new work which can be undertaken by the plant in the near future. The chart is sent to the Bureau of Ordnance via the plant administration.

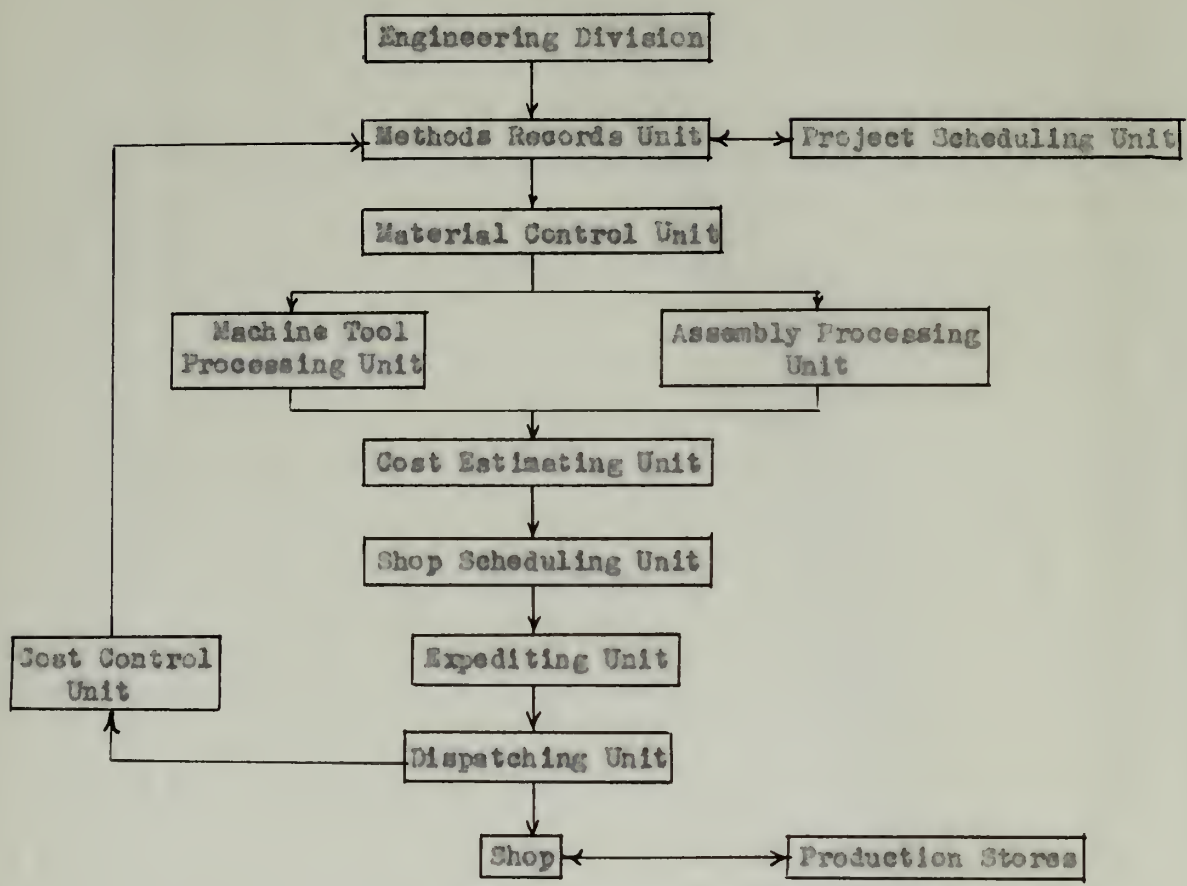
The Load and Performance Chart, shown in Figure 7, represents the efficiency of the shop relative to the time estimates of the Cost Estimating Unit. This chart serves as an efficiency standard for the shop, showing the amount of work completed by the shop against the amount of work released to the shop by the Production Control Division. Sources of the chart's information are the Weekly Machine Load Report and the Fiscal Labor Report.

The Monthly Man Load Summary is in the form of a letter stating

the general flow of work between the Units of the Production Control Division.

General Work Flow Diagram

Production Control Division

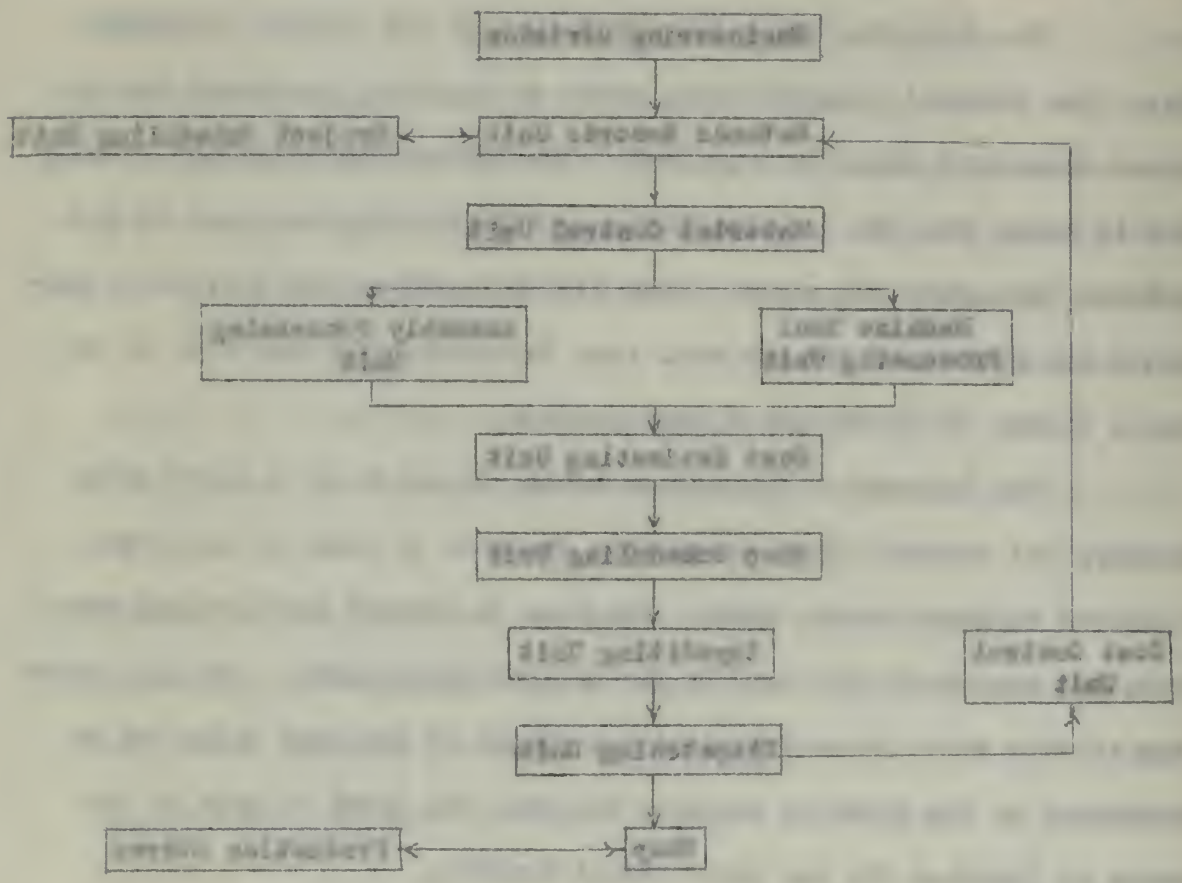


The functions of the various units are described on the following pages.

the general flow of work between one-data of the information system details.

Command Code Flow Diagram

Production Manual Entry



The functions of the various units are described on the following pages.

J. O. #

Complete Engineering Release

Operation	Due	Complete
Final BD & BM's		
Make Routings		
Make Kits		
Assy Routings		
Assy Kits		
Raw Materials		
Purchased Parts		
Make Parts		

Remarks:

(1) If for any reason your portion of the above schedule cannot be met, please notify the undersigned immediately.

(2) When your portion of the above schedule is completed, please date, initial and return this form to the undersigned.

C. O. McGaughey
Project Scheduling Unit

Fig. 5 Internal Schedule

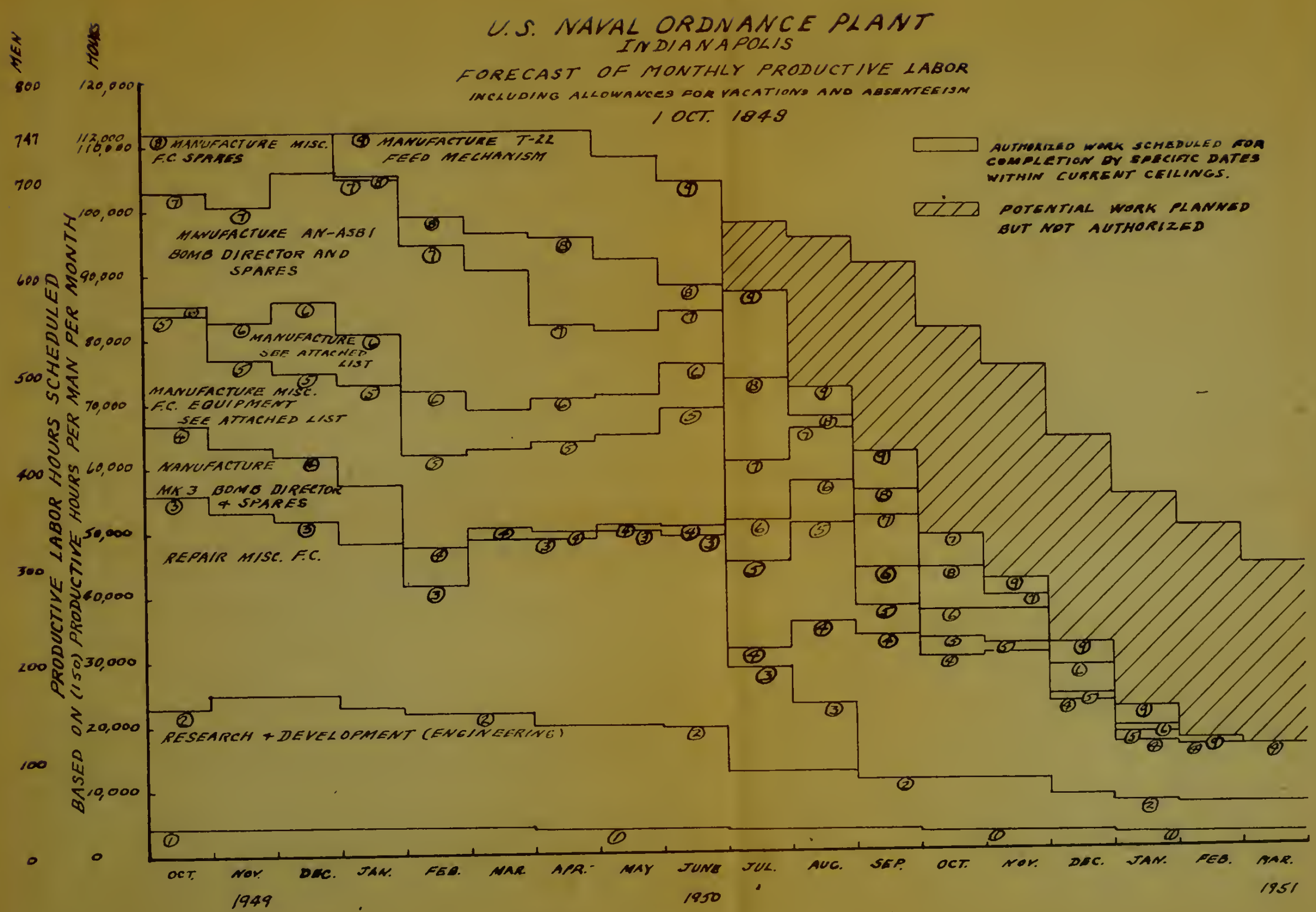


Fig. 6 Forecast of Productive Labor Chart

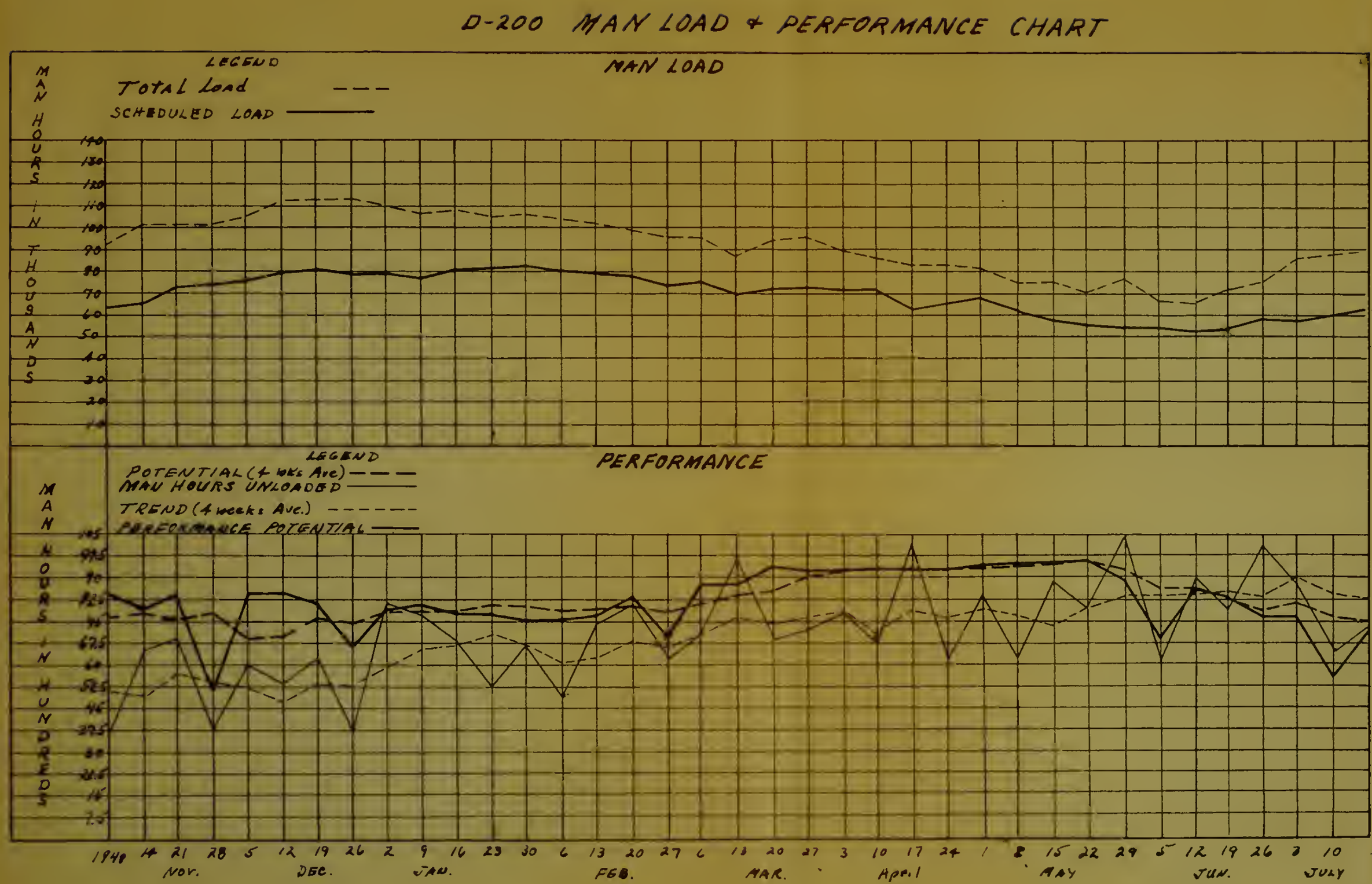
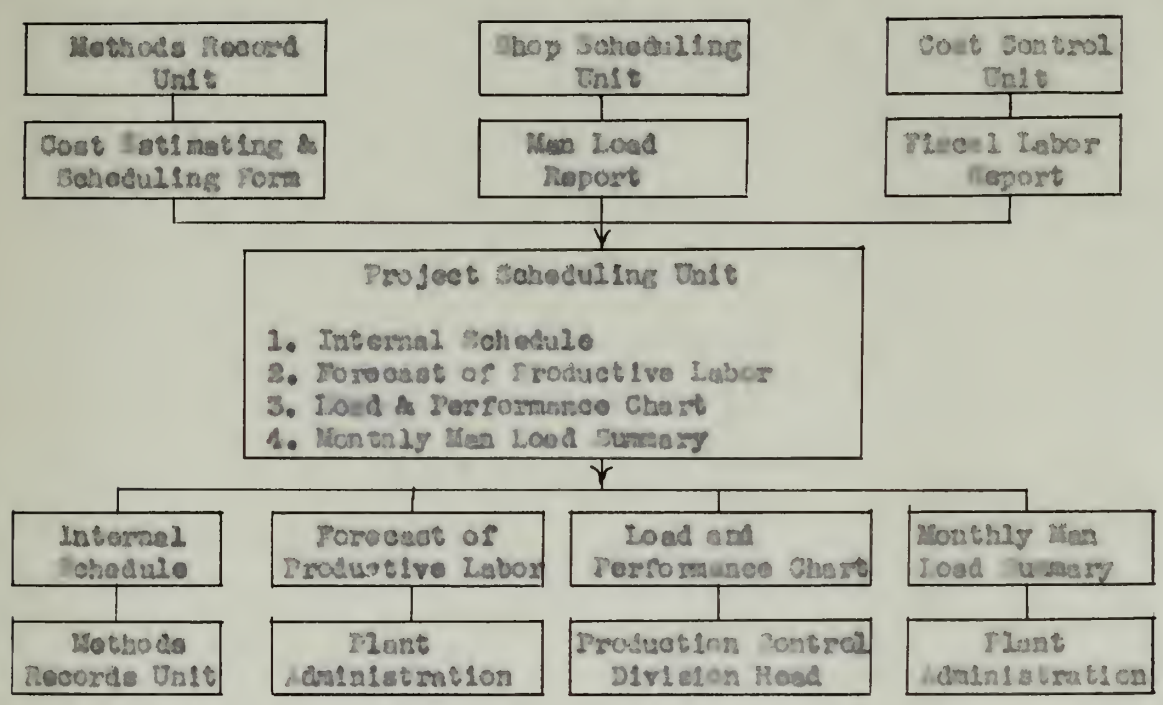
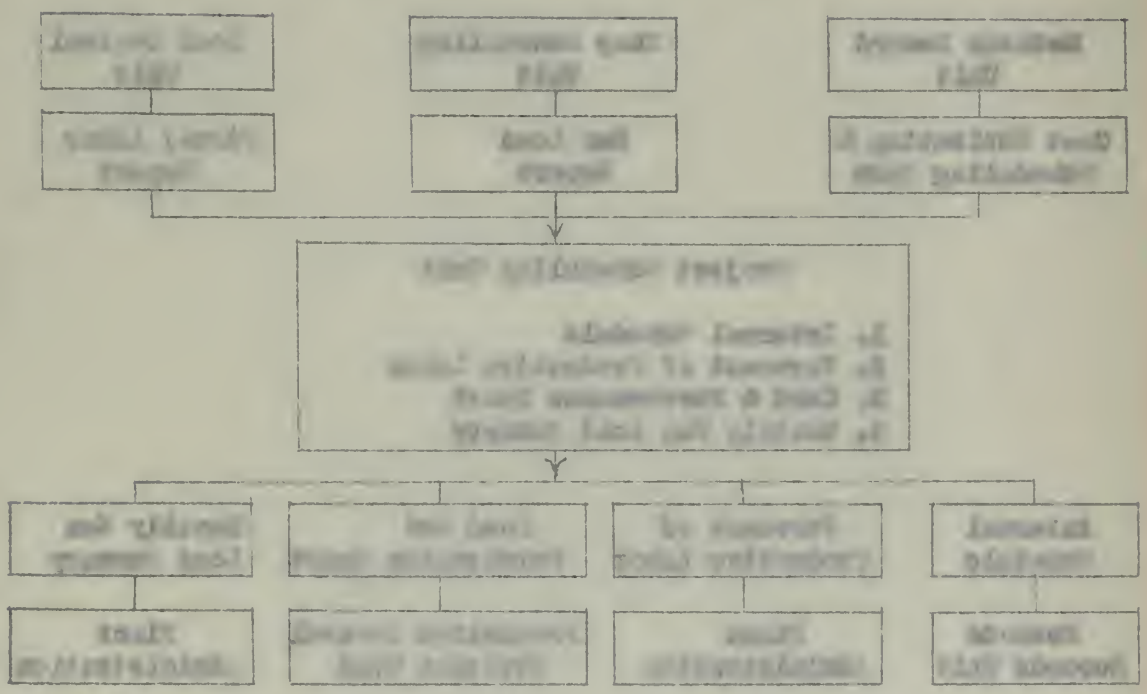


Fig. 7 Load and Performance Chart

the man-hours of machinery, assembly, and tooling completed in a month. Based on the Forecast of Productive Labor, this summary recommends transfers of labor between divisions and the adjustment of the labor force to meet the production requirements of the immediate future. It also contains a brief account of the status of all projects, a report on the important occurrences in and outside of the plant during the past month (such as a national coal strike), and their effect on the progress of the plant's various projects. This summary is used for administrative guidance.

The flow of information into the Unit, the forms originated therein, and their destination are shown in the diagram below.





The Methods Records Unit

The Methods Records Unit is responsible for receipt, stowage, and distribution of Engineering data and for keeping the many files up to date. These files contain a variety of items, such as job orders, blueprints, parts lists, production breakdown sheets, and many others. One of the other responsibilities of the Unit is to act as a collecting agency in making up the "folders" that are originated to implement the production of a new part. It is obvious that it is necessary to have some means of keeping track of just how each job is progressing pertaining to the necessary preparation of prints, routings, and such other work that must be completed prior to release of the job order to the Shop Scheduling Unit. The Methods Records Unit accomplishes these functions.

When a new part appears on the Production Breakdown Sheet, a folder containing the necessary information on the part is made up and sent to the Machine Tool Processing Unit where the Process Routing Sheet is made up on vellum paper. This accompanies the folder and is then sent to the Cost Estimating Unit via the MethodsRecords Unit so that they are able to tell at all times just what progress is being made on the "folder." The Cost Estimating Unit fills in the operator and set-up times in the proper columns on the Process Routing Sheet, and the folder is then returned to the Methods Records Unit for reproduction and distribution of the Process Routing Sheet. The folder is kept in a current file as long as the part is being produced in the plant.

Items of different forms are received by the Unit, reproduced in the required number and distributed according to the needs. For instance, Parts Lists are reproduced and sent to the following:

1. Original to file
2. Material Control
3. Assembly
4. Methods Processing

Blueprints are reproduced and sent to the following:

1. Original to file
2. Tool Design
3. Salvage
4. Machine shop
5. Assembly

Process Routing Sheets are reproduced and sent to the following:

1. Original vellum to file
2. Machine shop
3. Assembly
4. Inspection
5. Tool Design
6. Tool Room
7. Scheduling
8. Salvage

1. Original file
2. Material testing
3. Assembly
4. Finishing treatments

Blueprints are prepared and sent to the collaborator:

1. Original to file
2. Work design
3. Pattern
4. Machine data
5. Assembly

Process Routing Sheets are prepared and sent to the following:

1. Original copies to file
2. Machine shop
3. Assembly
4. Inspection
5. Tool design
6. Tool room
7. Painting
8. Storage

The Material Control Unit

The Material Control Unit requisitions the raw materials and purchased parts required for the plant's production. It is responsible for initiating the screening of the supply system for available material, and for determining the component parts and their quantity to be manufactured in the plant.

In the interest of an economical material cost, the Unit, assisted by the Supply Department, investigates the required raw materials and purchased parts to determine the materials available in the extensive supply system. For this purpose the Unit originates the Firm Requirement and Obligation of Material Form, Figure 8. When the required material is available, the Unit requisitions it through the Supply Department, the procuring agency for raw materials and purchased parts.

The Production Breakdown Sheet, Figure 9, is issued by the Unit. This sheet contains information as to the quantity of each component part of a project, determined by the Unit from the parts list, prints, and an estimation of scrap and losses. The Production Breakdown Sheet, the authorization to manufacture a specific quantity of a component part, is widely distributed throughout the Production Control Division.

Also issued by the Unit is the Stub Requisition, Figure 10, for raw materials and purchased parts. It is the Unit's request for the Supply Department to procure the required raw material or purchased parts, either from the supply system or from a commercial concern.

The following diagram shows the flow of information into the Material Control Unit, the forms it originates, and the information which leaves the Unit.

The Municipal Electrical Utility

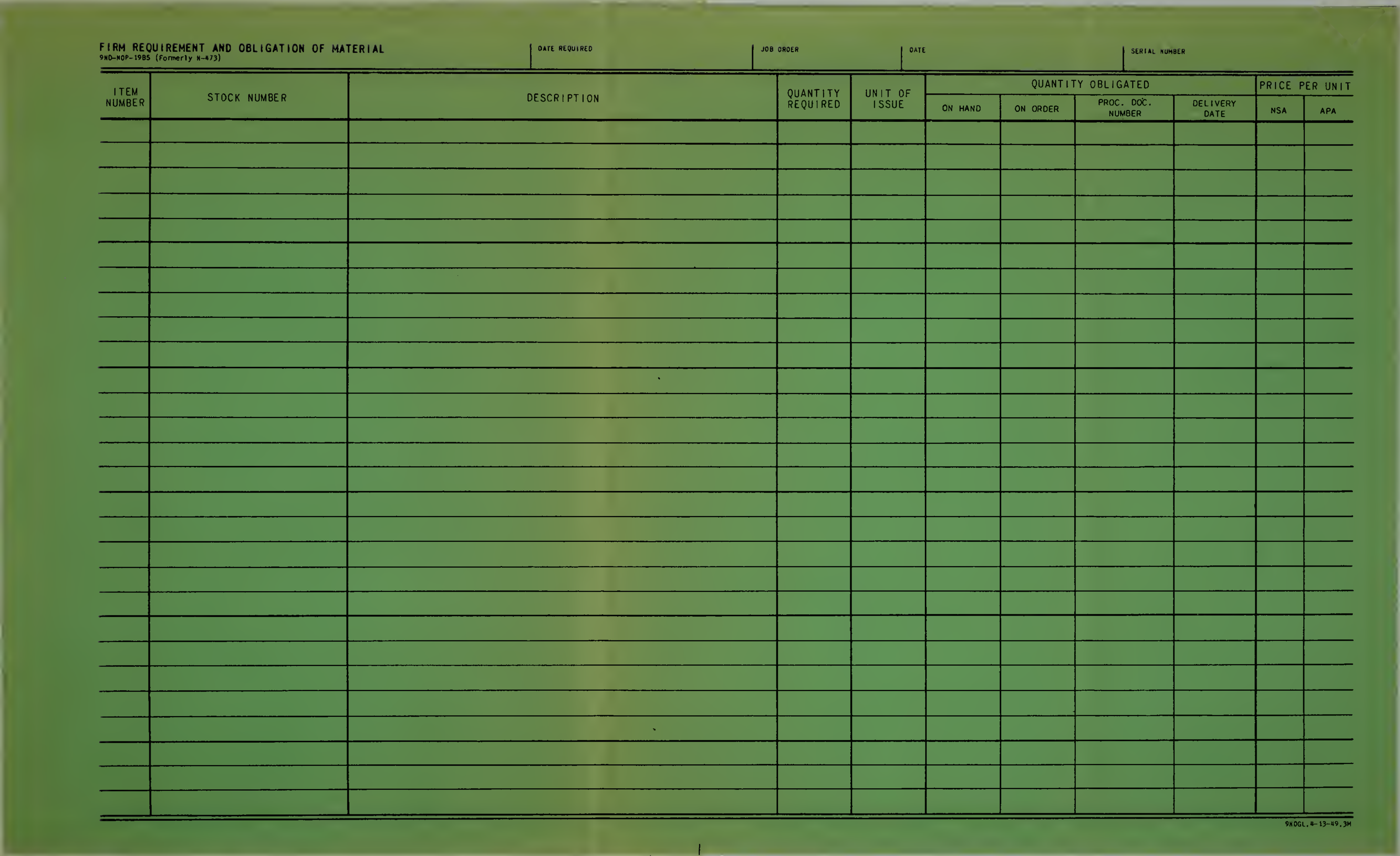
The Municipal Electrical Utility manufactures and sells electricity and performs light, heating and power installations. It is responsible for maintaining the municipal electric supply system, including the municipal street lighting system, and for maintaining the municipal radio and audio communication system in the province.

In the Summer of 1963 municipal electrical meters, for utility customers in the Capital Territory, disappeared and were replaced with new meters and precisely quartz clocks to determine the minutiae available in the municipal supply system. The main purpose the Utility anticipates the time-saving and facilitation of Electrical Utility Figure 6. When the required deployment is completed, the Utility anticipates to finance the Capital Development, the production among the new authorities and provincial review.

The Electricity Generation Plant, Figure 7, is fuelled by the Utility. This plant includes electricity as the quantity of water dispensed part of a project, interrupted by the Utility and the public light, private, and as particulars of water and lighting. The Electricity Generation Plant, the municipalities to generations a electricity specially as a hydro-power plant, is widely distributed throughout the Transmission Network Division.

Also issued by the Utility is the Power Regulation, Figure 8, for the municipalities and provinces power. It is the Utility's request the use Supply Commission to provide the meters was required to provinces power, either from the Supply system or from a commercial source.

The Utility Figure shows the flow of information into the Electrical Control Unit, the first is original, and the information which leaves the Unit.



FIRM REQUIREMENT AND OBLIGATION OF MATERIAL
9ND-NOP-1985 (Formerly N-473)

DATE REQUIRED

JOB ORDER

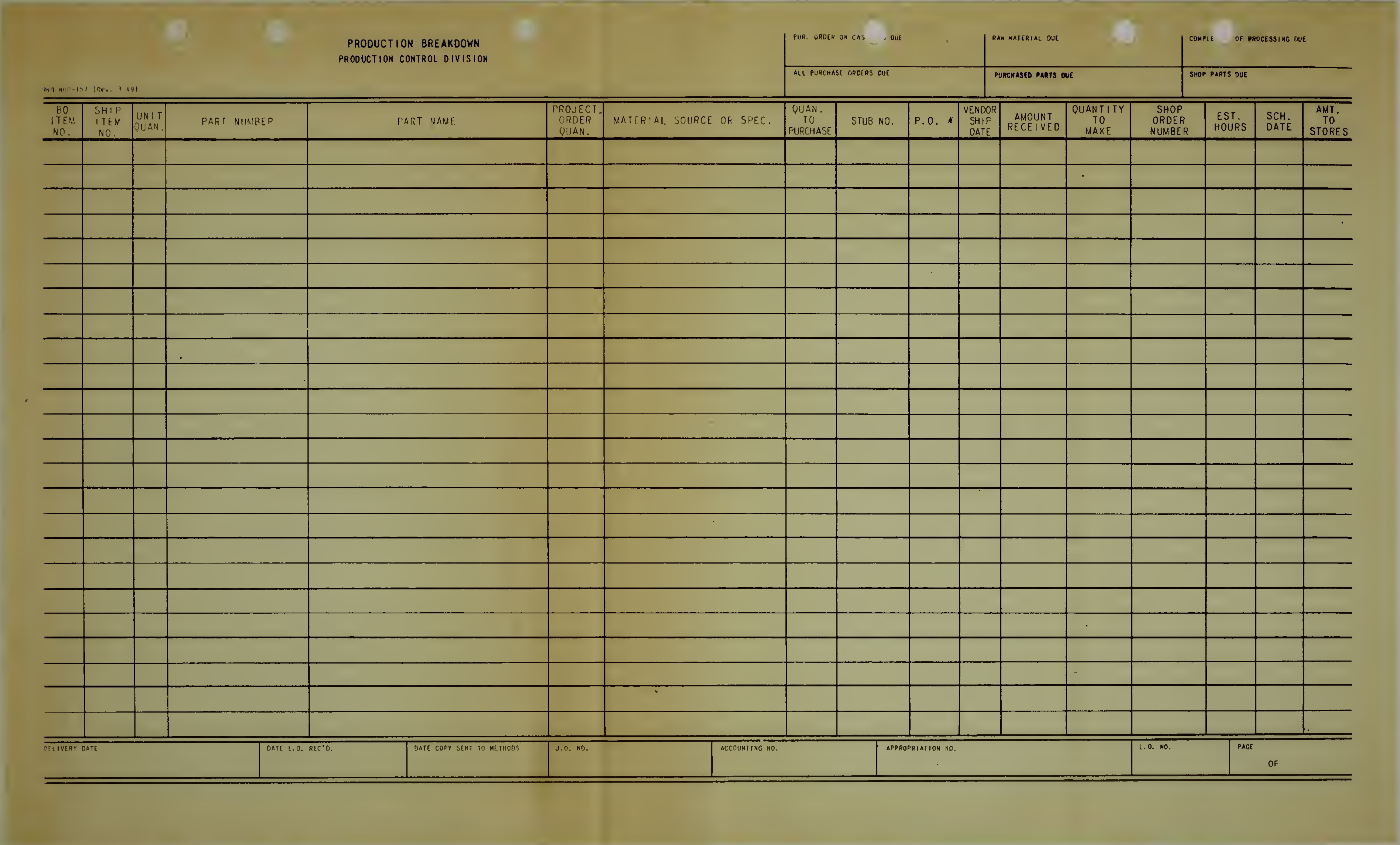
DATE

SERIAL NUMBER

ITEM NUMBER	STOCK NUMBER	DESCRIPTION	QUANTITY REQUIRED	UNIT OF ISSUE	QUANTITY OBLIGATED				PRICE PER UNIT	
					ON HAND	ON ORDER	PROC. DOC. NUMBER	DELIVERY DATE	NSA	APA

9NDGL.4-13-49.3M

Fig. 8 Firm Requirement and Obligation of Material Form



PRODUCTION BREAKDOWN
PRODUCTION CONTROL DIVISION

PNO NOC-157 (Rev. 3 49)

PUR. ORDER ON CAS[illegible] DUE
ALL PURCHASE ORDERS DUE
RAW MATERIAL DUE
PURCHASED PARTS DUE
COMPLE[illegible] OF PROCESSING DUE
SHOP PARTS DUE

BO ITEM NO.	SHIP ITEM NO.	UNIT QUAN.	PART NUMBER	PART NAME	PROJECT ORDER QUAN.	MATERIAL SOURCE OR SPEC.	QUAN. TO PURCHASE	STUB NO.	P.O. #	VENDOR SHIP DATE	AMOUNT RECEIVED	QUANTITY TO MAKE	SHOP ORDER NUMBER	EST. HOURS	SCH. DATE	AMT. TO STORES

DELIVERY DATE	DATE L.O. REC'D.	DATE COPY SENT TO METHODS	J.O. NO.	ACCOUNTING NO.	APPROPRIATION NO.	L.O. NO.	PAGE OF

Fig. 9 Production Breakdown Sheet

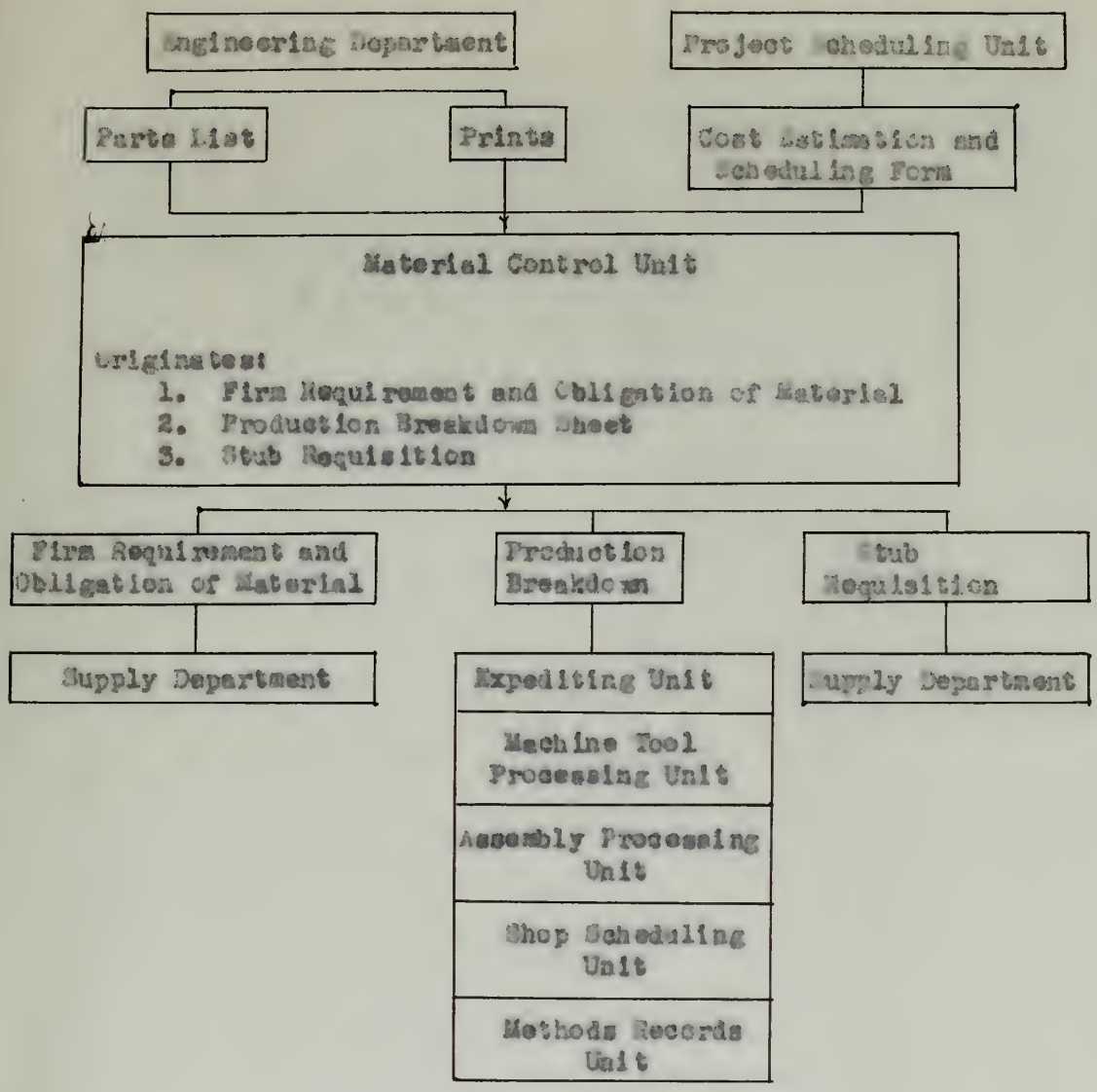
STUB NO.	SHOP	SHIP OR STATION	JOB ORDER NO.	WORK CLASS	APPROPRIATIONS CHARGEABLE	PROJ. OR ALLOT.	OBJ. CLASS.	ACCT. EX-PENDED FROM	DATE

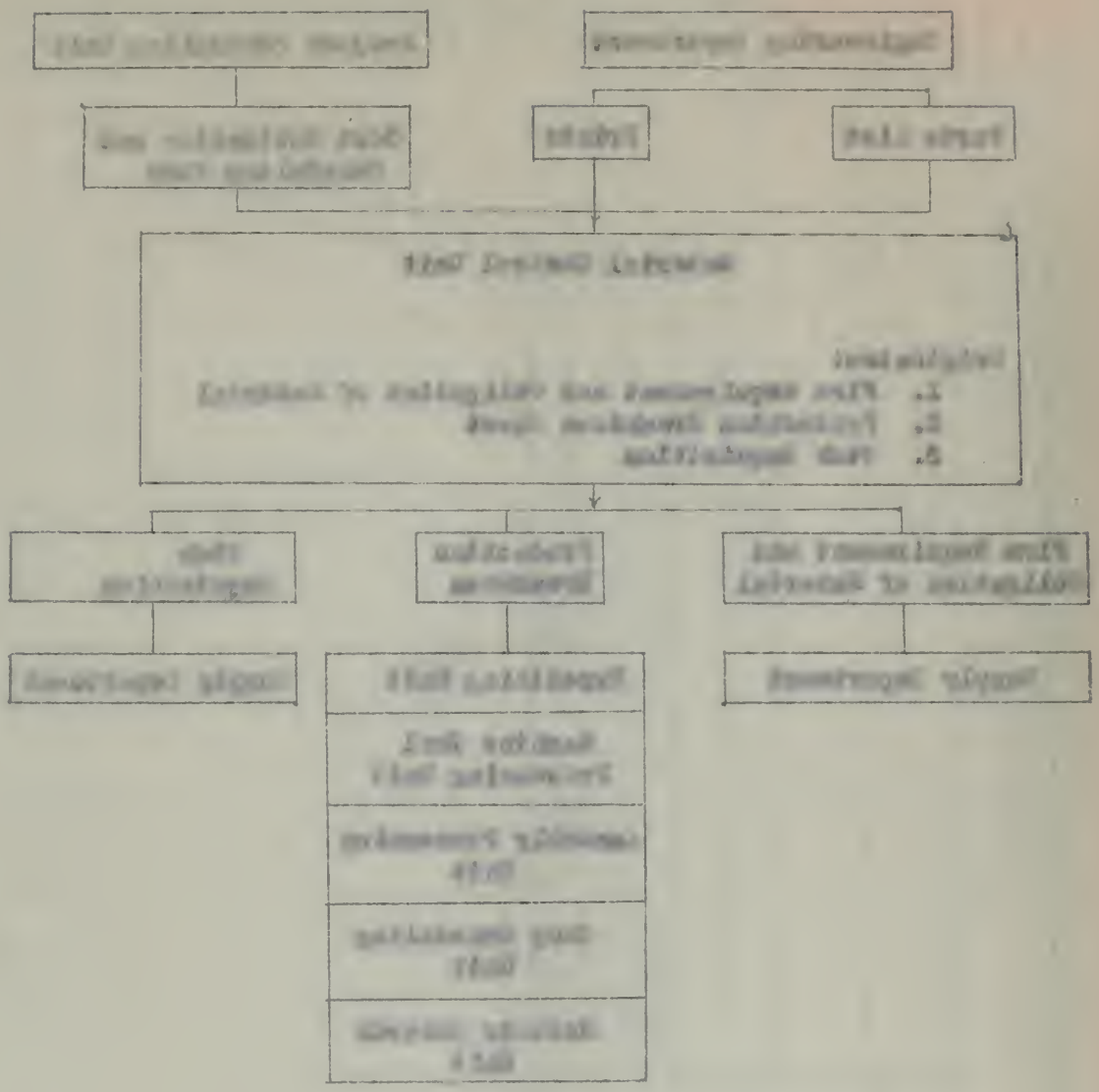
UNIT OF ISSUE	QUANTITY	UNIT PRICE	EXTENSION		CLASS AND STOCK NUMBER	DESCRIPTION
		TOTAL			DELIVERY POINT	MISCELLANEOUS

PRIORITY INDICATOR	APPROVED BY	ISSUED BY (DATE)	REC. VOUCHER NO.	RECEIVED BY DATE SIGNATURE	1
DATE DEL'Y DESIRED	SCHEDULE	LEAVE STOCK CONTROL	LEAVE STORES	LEAVE DELIVERY	DELIVER AND CHARGE AS INDICATED SIGNATURE

STUB REQUISITION NAV. S. AND A. FORM 129 (9M) (REV. 2-48)

Fig. 10 Stub Requisition


Engineering Department
Project Scheduling Unit
Parts List
Prints
Cost Estimation and Scheduling Form
Material Control Unit
Originates:
1. Firm Requirement and Obligation of Material
2. Production Breakdown Sheet
3. Stub Requisition
Firm Requirement and Obligation of Material
Production Breakdown
Stub Requisition
Supply Department
Expediting Unit
Machine Tool Processing Unit
Assembly Processing Unit
Shop Scheduling Unit
Methods Records Unit
Supply Department



The Machine Tool Processing Unit

The Machine Tool Processing Unit originates the operation sheet for each component part to be manufactured in the plant, and issues requests for the designing and building of the special tools, jigs, fixtures, and gages required in the manufacture of these component parts.

This unit performs the work normally assigned in industry to the Production Planning Department. The Process Routing (or operation) Sheet, Figure 11, is one of the most important records kept by a manufacturing company, representing the "know-how" in the manufacture of component parts. It is formulated from the Parts List, Production Breakdown, and Internal Schedule received by the Unit.

The Tool Design and Build Order Form, Figure 12, is originated in the Unit from the information contained in the Parts List, the Production Breakdown, and the Process Routing Sheet. It outlines in general terms the tools, jigs, fixtures, and gages which the Tooling Division designs and builds for the manufacture of the component parts.

The following diagram shows the flow of information to the Machine Tool Processing Unit, the material originated in the Unit, and the next destination of that material.

The Electric Foot Pressure Unit

The Electric Foot Pressure Unit indicates the operation some for each successive part to be accomplished in the plant, and the same requests for the indicators and totalizer at the special remote sign. Electrons, and power required in the accomplishment of these requests twice.

This unit replaces the work formerly required in balancing in the Pressure Reading Department. The Pressure Reading Line operation sheet, Figure 12, is one of the most significant results that is a case Reading equipment, replacement the "Gain-Act" in the accomplishment of equipment plants. It is recommended from the Study Lab, Industrial Engineering, and Internal Technical Publication by the Co.

The Part Sketch and Block Diagram Form, Figure 13, is reproduced in the Unit from the Instrumentation Department in the Tender Lab, the Pressure Measurement, and the Pressure Reading Department. It contains in general order the Block, Figure, Diagram and Equip which the Testing Lab also Design and Build for the requirements of the equipment plants.

The Relationship diagram shows the flow of information in the Electric Foot Pressure Unit, the material relationship in the Unit, and the work Description of that material.

Fig. 11 Process Routing Sheet

REQUEST FOR TOOL DESIGN AND BUILD ORDER
N 485 (Rev. 11-49)

DATE

UNIT TYPE

J.O. NO.	APPR. NO.	ACCT.	B. O. ITEM	PRIORITY	DATE WANTED
S.A. NO.	MK.	PART NO.	OPER. NO.	ROUTING DATE	NO. PARTS
SHOP ORDER NO.	MACH.	UNIT NO.	MATERIAL		

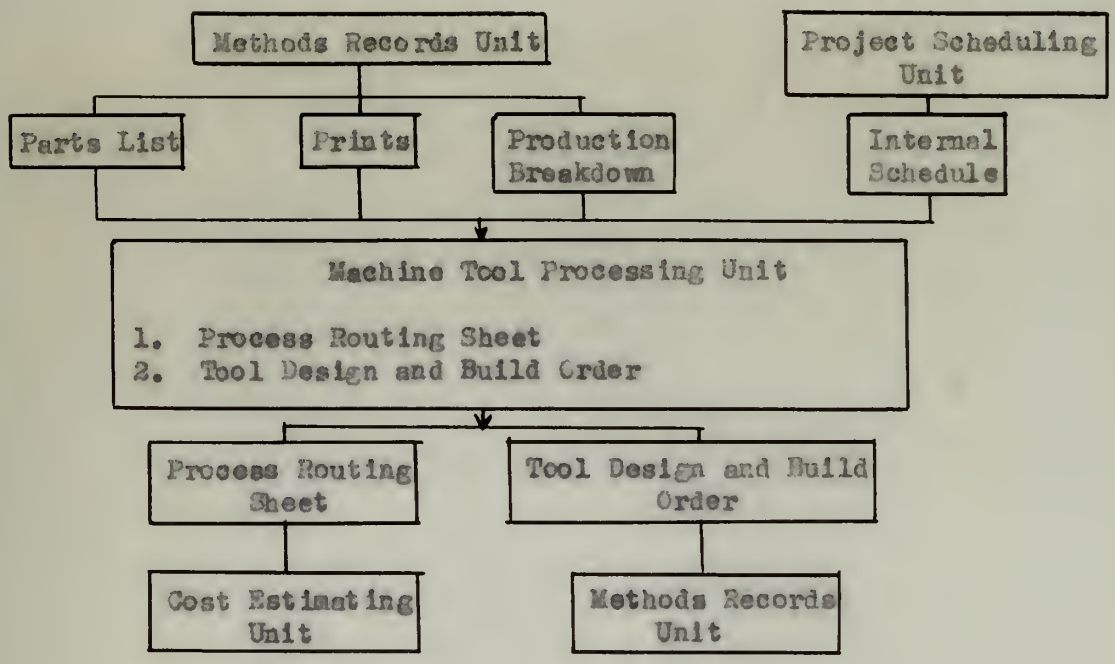
DESCRIPTION OF TOOL TO BE MADE

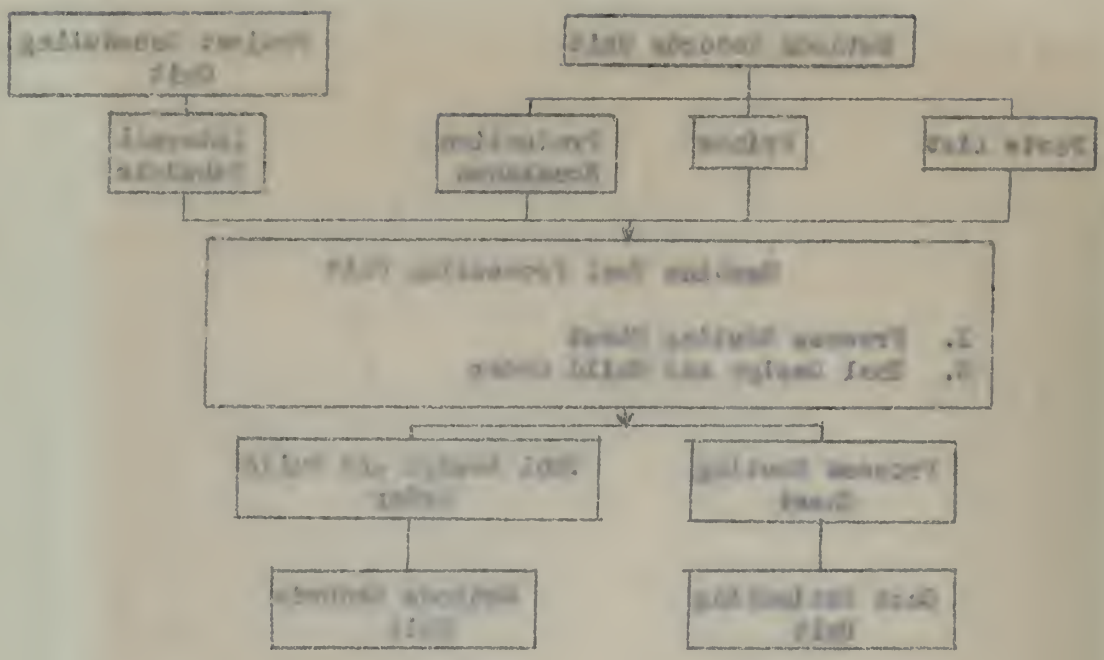
NOTE: Sketch of work to be done should accompany the order if possible showing critical dimensions.

DESIGN COMPLETED	REQUESTED BY	APPROVED BY

☐ NO. 1 COPY-METHODS ☐ NO. 2 COPY - TOOL DESIGN ☐ NO. 3 COPY - TOOL STORES

Fig. 12 Tool Design and Build Order Form


Methods Records Unit
Project Scheduling Unit
Parts List
Prints
Production Breakdown
Internal Schedule
Machine Tool Processing Unit
1. Process Routing Sheet
2. Tool Design and Build Order
Process Routing Sheet
Tool Design and Build Order
Cost Estimating Unit
Methods Records Unit



The Assembly Processing Unit

The Assembly Processing Unit originates the assembly operation sheet and issues orders for the tools, jigs, fixtures, gages, and test equipment required for the assembly process.

The specialization of the plant's final product, aviation fire control equipment, requires a great amount of assembly work. Since the knowledge of instrument assembly is highly technical, the Unit must provide a detailed write-up of the assembly of an aviation fire control system.

The Assembly Process Routing Sheet, in form similar to Figure 11, is originated in the Assembly Processing Unit. Experience is the most important factor in the writing of this sheet, which is constructed from the information contained in the Parts List, the Prints, and the Production Breakdown Sheet.

The Tool Design and Build Order Form, similar to Figure 12, is based on information from the Parts List, Prints, and Assembly Process Routing Sheet. The Assembly Process Routing Sheet also includes details of the required inspections; the Unit orders the special test equipment for these inspections. In some cases available commercial equipment is modified for this purpose, while in others special test equipment must be designed.

Equipment must be assembled in a definite sequence of operations; the Shop Scheduling Unit is furnished this information in the form of a letter, the Letter of Assembly Kit Sequence, which is a guide to the proper sequence of issuing the Assembly Kit.

The following diagram shows the flow of the more important information into the Unit, the material originated in the Unit, and the

The Assembly Processing Unit

The Assembly Processing Unit includes the Assembly Processing plant and having regards for the design plan, directory, power, and other equipment required for the Assembly process.

The specifications of the plant's plan, personnel, operation plan, general equipment, preparing a power source or hydraulic room. Since the knowledge of Instrument assembly is highly technical, the Unit must provide a detailed outlook of the assembly it or private from personal opinion.

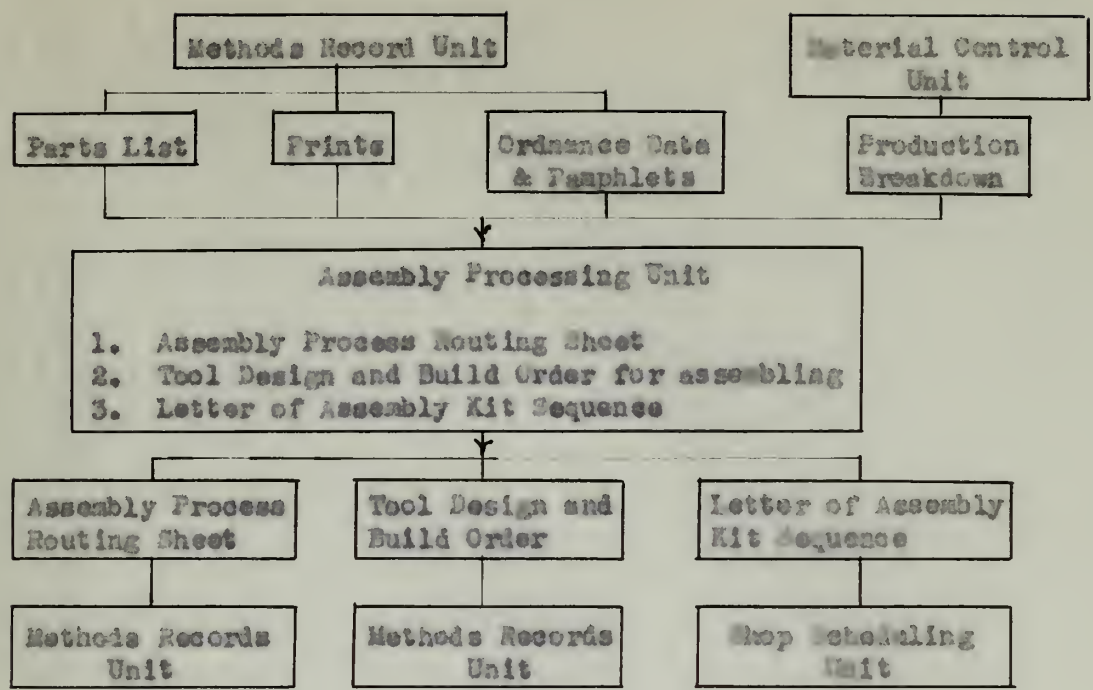
The Assembly Process Analysis Sheet, in the shelfs in figure 32, is attached to the Assembly Processing Unit. Importance is the most important factor in the utility of this sheet, using it structures from the microscopic analysis to the final item, the factors, and the Production Processing Sheet.

The Tool Table and Bill Tool Table, utilize in figure 33, is based on information from the Bill List, drawing, and Assembly Processing Sheet. The Assembly Process Sheet lists the necessary details of the physical requirements the tool which the tools will replacement for these instruments. The more water available Processing equipment is matched for this purpose, which is always special tool equipment and be designed.

Equipment must be assembled in a sequence manner or operations where the Long Assembling Unit is functions into Processing in the form of a Series, the Labor or assembly Bill requires, which is a guide to the proper sequence of Issuing the assembly Bill.

The Bilinolog diagram shows the flow of the work Processing Processing take the Bill, the material outlined in the Bill, and the

information departing from it.



The Cost Estimating Unit

The Cost Estimating Unit originates an estimated cost of each project undertaken by the plant, including the project's direct labor and material costs.

The component parts to be manufactured in the plant are estimated from information received from the Material Control Unit and other sources. The Cost Estimate Work Sheet, Figure 13, is used to compile data and compute total costs; this information is transferred to the Cost Estimation and Scheduling Form.

Probable operations and the time required for each are estimated by the Unit. The Machine Tool Processing Unit and the Assembly Processing Unit assist in the estimation of the operations required for the manufacture of each component part. This data is entered on the Estimate Routing Sheet, Figure 14.

The time in man-hours required for each operation, including the machine tool set-up time is estimated from past experience by the Unit.

As an aid to the maintenance of an accurate estimate of labor time required for each operation, the Unit records the actual time required at the completion of the job. With this information available, the Unit is able to keep current the time estimates in relation to the actual operation time. The estimated times are recorded on the Cost Estimate Work Sheet and the Process Routing Sheet.

The Unit keep the Material Cost Card, Figure 15, for the purpose of estimating the project's material cost. Information from the purchase orders, which contain the current cost of materials, is transferred to the Material Cost Card which furnishes an up-to-date record

[illegible] The Data Processing Unit

The Data Processing Unit Supervisor is responsible for the [illegible] of the [illegible] by the clerks, insuring the [illegible] shows [illegible] the material [illegible].

The component parts to be monitored in the plant are received from functionaries receiving from the Material Control Unit and storage rooms. The data flows follows from Chart, Figure 12, is used to supply data and complete [illegible]; this information is transferred to the Cost Estimating and Scheduling Unit.

Production operations and the time required for each are initiated by the Unit. The Master Tool Programmer Unit / the Unit Manager Programming Unit checks in the [illegible] of the operations required for the construction of each component part. This data is stored in the Estimate Costing Chart, Figure 14.

The time is non-zero required for each operation. Included the master tool set-up time is calculated from [illegible] by the Unit.

In the [illegible] of the [illegible] [illegible] time required for each operation, the Unit [illegible] the [illegible] time required at the completion of the job. Still more interesting [illegible], the Unit is able to keep [illegible] the time [illegible] is [illegible] by the actual operation time. The estimated times are processed to the Cost Estimate Note Sheet and the Process Costing Chart.

The Unit keep the Material Note Chart, Figure 15, for the purpose of [illegible] the employee's [illegible] work. Information from the [illegible] cards, which contain the [illegible] and [illegible], is transferred to the Material Note Card which [illegible] as [illegible] [illegible]

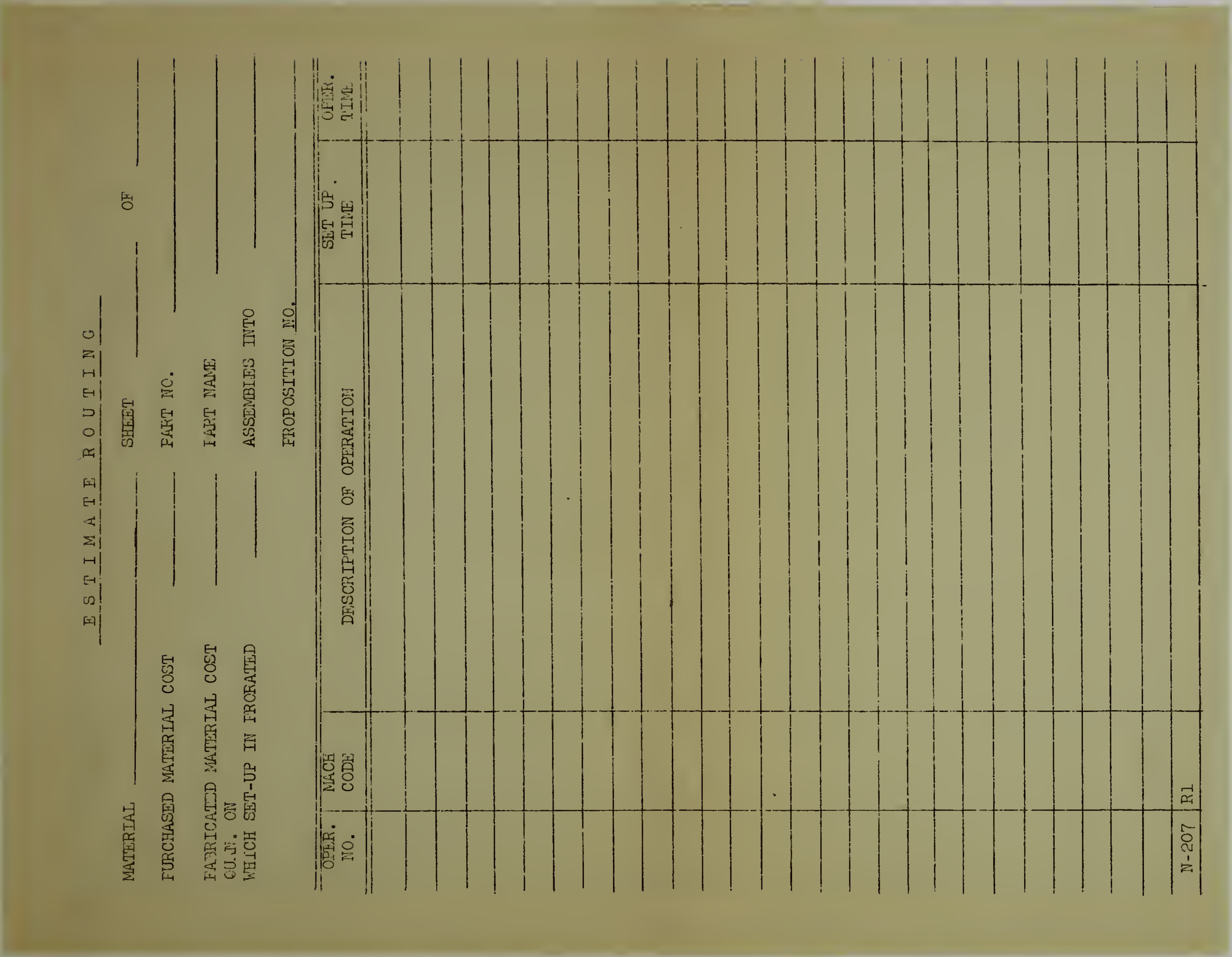
9ND-NOP-286

COST ESTIMATE WORK SHEET

SHEET OF SHEETS | PARTS LIST NO. | PROP. NO. | PJO NO. | P. OR R NO. | DATE

ITEM	PART NUMBER	DESCRIPTION	MAKE OR PUR.	QUANITY	MATERIAL COST								STD. TIME PER PIECE				DIRECT LABOR COST							
					FABRICATED				PURCHASED				ASSEMBLY		MACH. TOOL		ASSEMBLY @				MACHINE TOOL @			
					UNIT		TOTAL		UNIT		TOTAL		UNIT HR.		UNIT HR.		UNIT		TOTAL		UNIT		TOTAL	

9NDGL, 7-15-47, 500



ESTIMATE ROUTING

MATERIAL ____ SHEET ____ OF ____
PURCHASED MATERIAL COST ____ PART NO. ____
FABRICATED MATERIAL COST ____ PART NAME ____
G.U.N. ON WHICH SET-UP IN PRORATED ____ ASSEMBLIES INTO ____
PROPOSITION NO. ____

OPER. NO.	MACH CODE	DESCRIPTION OF OPERATION	SET UP TIME	OPER. TIME
N-207	R1			

Fig. 14 Estimate Routing Sheet

MATERIAL COST CARD

PART NUMBER_____

PURCHASE ORDER	DATE	QUANTITY	DESCRIPTION	UNIT PRICE

9ND-ORD 187 (Formerly N-302)

9ND GL, 6-13-47, 200

Fig. 18 Material Cost Card

MATERIAL COST CARD

PART NUMBER

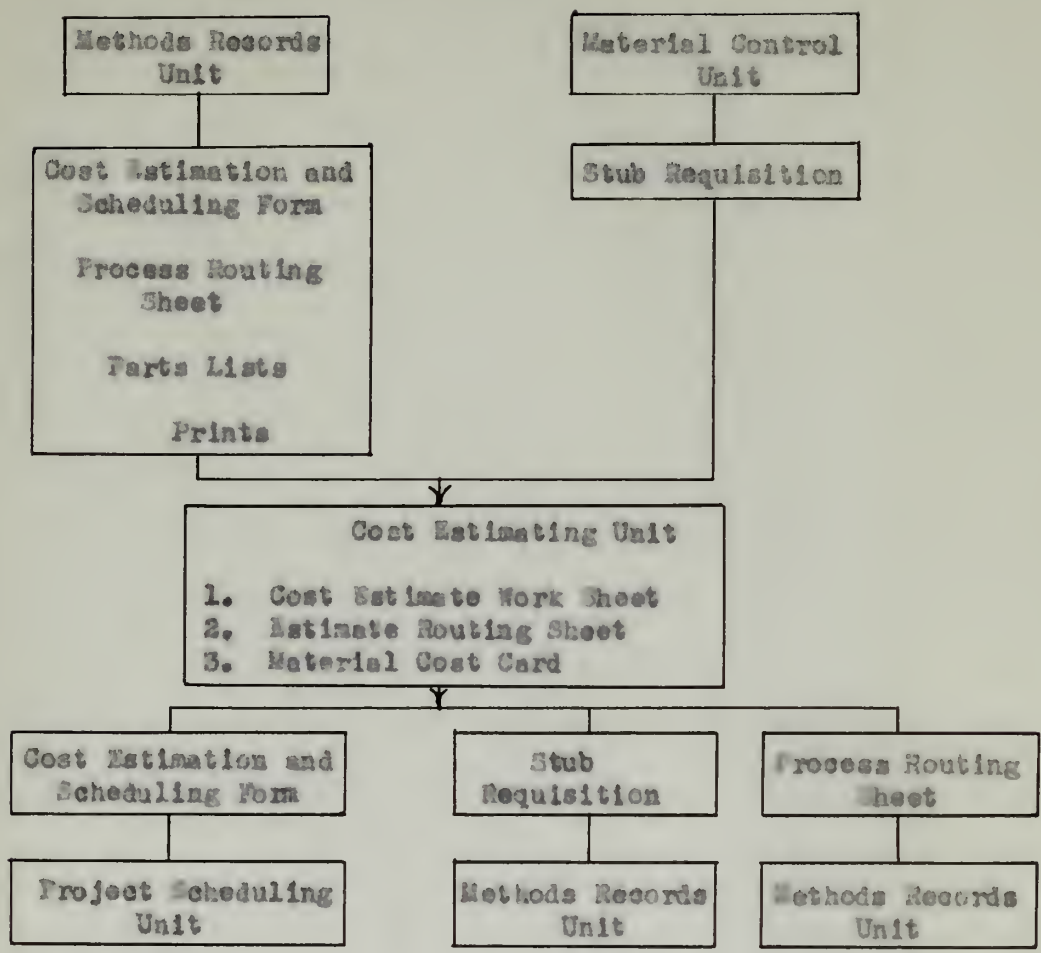
PURCHASE ORDER	DATE	QUANTITY	DESCRIPTION	UNIT PRICE

FORM 187 (Formerly 8-221)

REV 01, 8-12-17, [illegible]

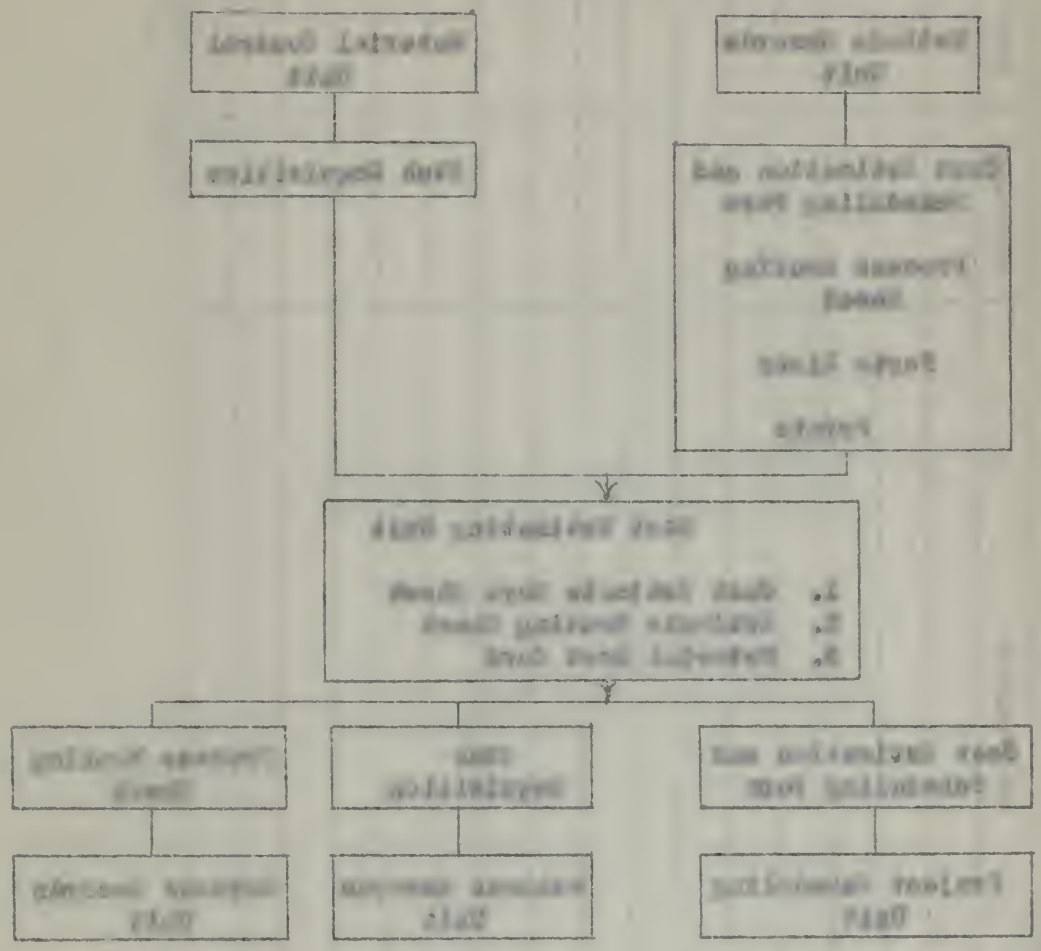
of material costs for the Unit.

The following diagram shows the flow of information into, through, and out of the Cost Estimating Unit.



of material needs for the Unit.

The following diagram shows the flow of information from customer, and vendor the Unit Purchasing Unit.



The Shop Scheduling Unit

The Shop Scheduling Unit assigns to the Machining Division the manufacture of the component parts and to the Assembly Divisions the assembly of these parts into completed items. The Unit maintains a current record of work load in man-hours, which forms the basis for the addition of new work to the shop.

Figure 16 shows the Shop Order Kit, the shop's authority to manufacture a component part on assembly. This form is compiled from information contained in the Process Routing and Production Breakdown Sheets and the Internal Schedule Form. The required month date of the component part's completion is given on the Shop Order Kit. The shop is thus scheduled for work by months in terms of man-hours. The Shop Order Kit consists of eight vari-colored IBM cards, each color having a specific usage. The yellow material identification card is the master card, accompanying the shop order from raw material to completed component part; the green card is the material requisition card, etc.

The Weekly Machine Load Summary, Figure 17, is issued by the Unit. It serves as a means of determining the relative operating efficiency of the various units of the Production Division, and is the basis for adding new work to the shop and adjusting potential man-hours of labor between the Production Divisions. This report contains information on the number of man-hours released to and completed by the shop, and the present amount of work available for the shop.

The Unit issues the Assembly Monthly Schedule which establishes the sequence of work to be accomplished by the Assembly Division during a month. Since there are many unpredictable time-consuming variables in the assembly of a highly complex instrument, the Assembly Division

[illegible] — The Shop Committee Unit

The Shop Committee Unit includes in the Committee division the representatives of the employees group and in the Committee division the assembly of every group into employees' groups. The Shop Committee a representative of work land in management, which forms the basis for the division of work order to the shop.

Figure 18 shows the Shop Committee Unit, the shop's authority is constituted a representative group in assembly. This unit is composed from Information established by the Firmness Meeting and Committee Assembly and the Internal Information Form. The position shall have of the management part's authority is given in the Shop Committee Unit. The shop is then submitted the right of member in terms of management. The Shop Committee Unit operates of which representative and shall, with their duties a committee. The representative Committee Unit is the master unit. Accompanying the Shop Committee Unit the activity is structured management part the lower unit in the material regulation unit, who.

The Shop Committee Unit Committee, figure 19, is formed by the Unit. It serves as a model of determining the working conditions activity of the regular units of the Committee Unit, and is the basis the ability the work in the shop and adjusting potential conditions of labor between the Committee Unit. This report contains information on the number of employees planned in the shop, and the general number of work available for the shop.

The Unit lists the assembly Unit includes which establishes the requests of work to be manufactured by the Assembly Division Assembly Unit. These have not only quantitatively information-giving worksheet is the specific of a highly complex instrument, the Assembly Division

REV. 1 | REV. 2 | REV. 3

J.O. & ITEM NO.	APPR. NO.	ACCT.	S.O. ITEM	PRIORITY	ESTIMATED HOURS
750	69	62459	150	A	U/221 - 10 HRS. U/223 - 60 HRS

PART NO.	AMT. ORDER	NAME	STARTING QUAN.	STUB NO.
325 652-1	100	BUSHING		215-3945

MATERIAL, SIZE & SPEC.	CODE	AMT. MAT. REQ'D.
#416 St. Stl. 1/2" Dia.	30	50'

SHOP ORDER NO.	SPEC. INFO.	AMT. MAT. ISSUED
1-1000		

		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
-	218	221		421	223							421	222	421	219				
	S/F																		
		95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180
	S/F																		

SAMPLE

9ND-HOP-435 (REV. 6-49) SHOP ORDER MASTER 9ND, GX, 9-2-49, A-145, 20M

Fig. 16 Shop Order Kit

[illegible] A1 (800)

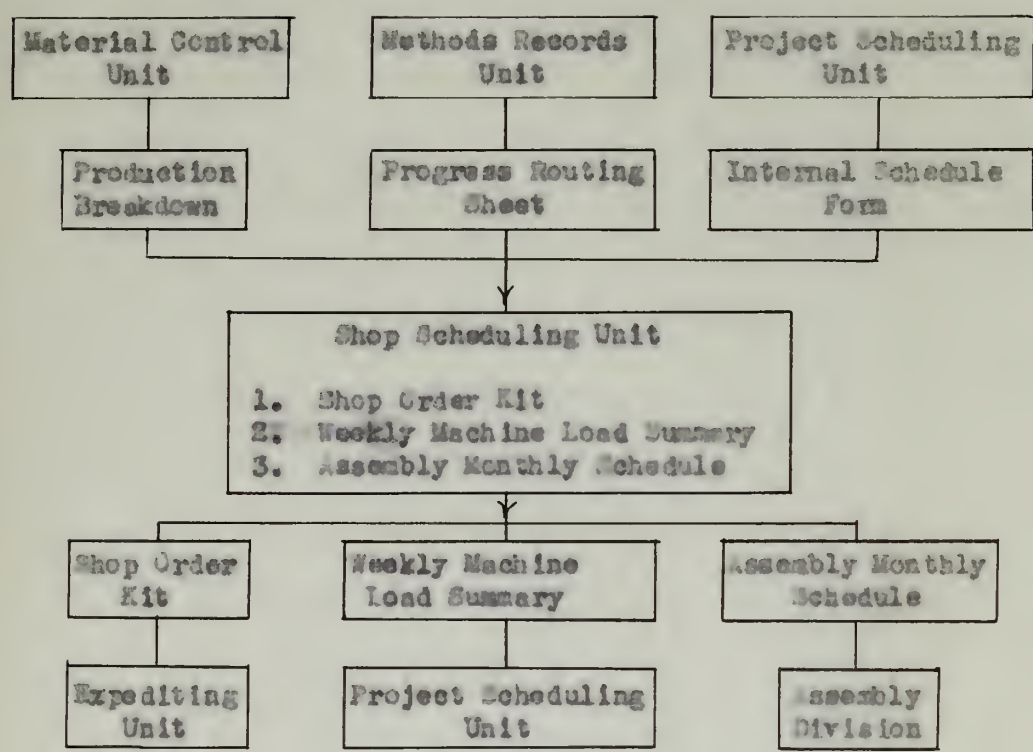
WEEKLY MACHINE LOAD SUMMARY

P.J.O.	TOTAL HOURS ASS'G'D	ASS'G'D DURING WEEK	TOTAL COMP TO DATE	HOURS COMPLETED 1 WEEK				U.H. = UNSCHEDULED HOURS, S.H = SCHEDULED HOURS							
				D/221	D/223 D/225	D/224	TOTAL	D/221		D/223 D/225		D/224		TOTAL	TOTAL
								U.H.	S.H.	U.H.	S.H.	U.H.	S.H.	U.H.	S.H.

Fig. 17 Weekly Machine Load Summary

is not scheduled for work in terms of man-hours per month. The probable time required is available in a rough estimate, from which data the Assembly Monthly Schedule lists the projects' priorities and the required monthly delivery rates of the assembly units. Normally, the Assembly Monthly Schedule overloads the Assembly Divisions in terms of man-hours of assembly work.

The important forms received in, originated by, and sent from the Unit appear below.



The Expediting Unit

The Expediting Unit is charged with the responsibility of seeing that the materials for a shop order are located physically in the plant prior to sending the shop orders to the shop and that all shop schedules are met. The Expediting Unit initiates suggestions for substitute materials, and originates requests for new work to replace the "rejects" on job orders.

In order to prevent confusion in the shop, Shop Order Kits are not released for manufacture until the necessary raw materials for them have been received in the plant.

After receiving the Shop Order Kit from the Method Records Unit, the Expediting Unit holds the kit until the Stub Requisition Receipt is received. This receipt is issued by the Supply Department after the material has been received. The Unit maintains a records of all Shop Order Kits and the required material for each; it also makes a weekly check of all kits being held up because of a lack of materials. A bi-monthly record of all such held-up kits is sent to the head of the Production Control Division. The Unit expedites the procuring of materials through the Supply Department. In some cases, the Unit originates a substitute material upon the approval of the Methods Section or the Engineering Division. In other cases, such a suggestion for substitutes comes from the shop or the Supply Department; the Unit is responsible for having these suggestions approved by the Methods Section or the Engineering Division.

When parts are rejected by the Inspection Division and scrapped by the Salvage Division, the information is recorded on the back of the Master Card in the Shop Order Kit. After the Expediting Unit receives

The Dispatching Unit.

The dispatching unit is charged with the responsibility of seeing that the materials for a job arrive at the proper department in the proper order to meeting the shop schedule as the shop has been well-organized and set out. The dispatching unit initiates requisitions for shipping materials, and reclamation requests for use with in matters the "material" on job cards.

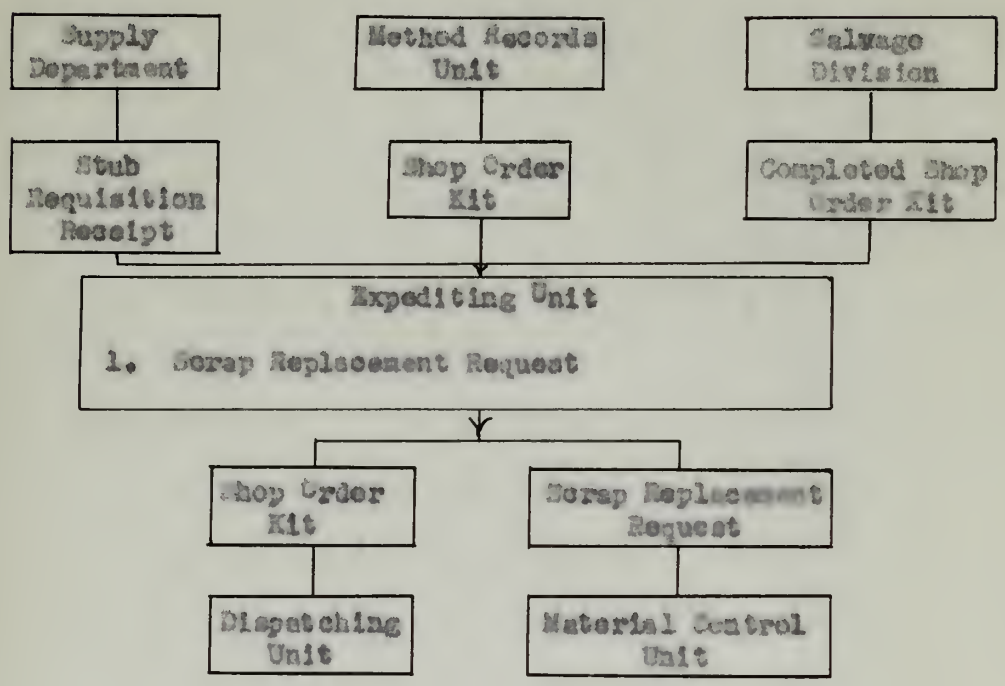
In order to prevent confusion in the shops, they inter-office mail but returned the materials until the accounting are satisfied the time have been recorded in the plant.

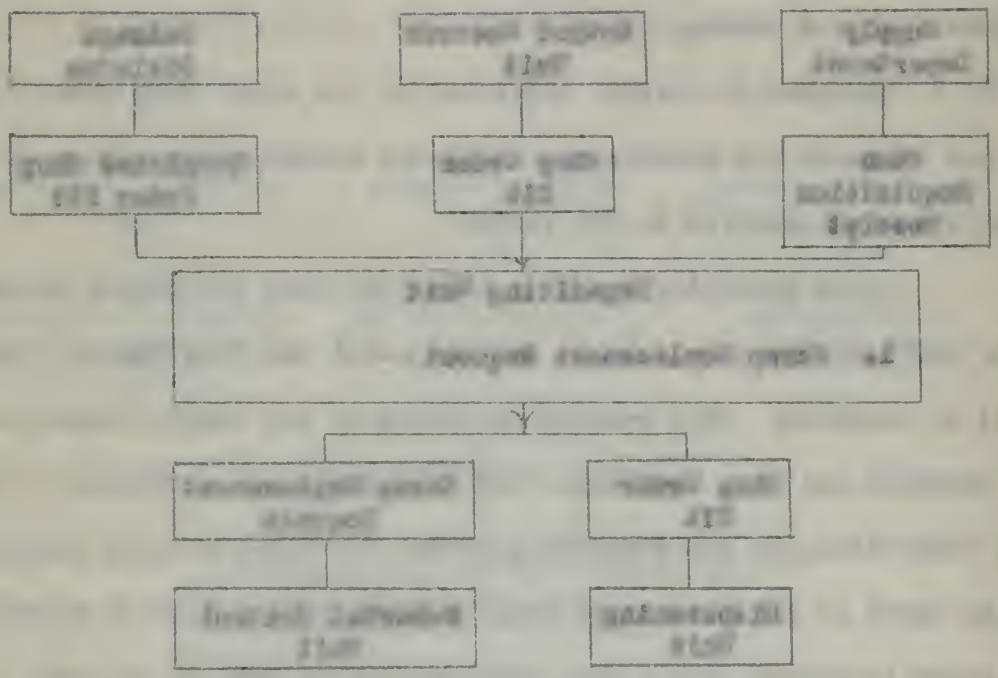
After receiving the job order all from the shops, Dispatching Unit, the dispatching unit notes the job until the time Dispatching Unit notify the shop that the material has been received. This permit is issued to the supply Department after the material has been received. The unit maintains a record of all shop order slip and the department supplies, for which it also makes a weekly check of all slips being held up because of a lack of material. A bi-monthly report of all such delinquent slips is sent to the head of the responsible control division. The unit maintains the performance record sheets for supply department. In some cases, the unit exercise a quantitative control over the expense of the various shops or the Purchasing Division. In other cases, such a suggestion for economies comes from the shop or the Supply Department; the unit is responsible for having these suggestions approved by the Purchase Department or the Engineering Division.

When parts are rejected by the Inspection Division and returned by the Storage Division, the information is received in the form of the matter that is the shop order slip. After the Dispatching Unit receives

the Master Card, it originates a "scrap replacement request." This form is sent to the Material Control Unit, after which it is handled in the same manner as the original Shop Order Kit.

A general work flow diagram of the Expediting Unit is shown in the chart below.





The Dispatching Unit

The Dispatching Unit is responsible for the releasing of work to the shop and assembly divisions in accordance with the schedule. The Unit performs "trouble-shooting" activities to coordinate the materials, machine tools, and work for the Production Division. The records charting the progress of the assigned work are kept by the Unit. The material handling problems of the plant are also a responsibility of the Dispatching Unit.

The Shop Order Kit is received from the Expediting Unit, and, with the exception of the Material Requisition Card, the kit is placed in the appropriate pocket board. The pocket boards are arranged by Machining and Assembly Units by months. The Shop Order Kit is taken from the pocket board by the Head of the Unit, who establishes the sequence of work in his unit, based upon the completion date on the Shop Order Kit. To start a new job, the operator obtains the Material Requisition Card from the Dispatching Unit, and draws the required material. The Unit assists in the movement of materials from the storeroom to the workplace. The Unit transfers the partially completed job to the next scheduled Unit, and the Shop Order Kit to the appropriate pocket board of the next scheduled Unit. Thus, the location of the Shop Order Kit in the pocket board serves as a progress record of the job. The high priority Shop Order Kits are designated by a special color code, and these jobs are given special expediting attention.

The Dispatcher's File Card, Figure 18, is used to record progress of the shop orders and tool shortages. The Unit makes a daily floor check, gathering the data on the operations on the jobs in process. This data is recorded on the Dispatcher's File Card.

The Stepmotherly Duck

The stepmotherly duck is responsible for the mishandling of eggs in the duck and assembly industries in Washington state's two economies. The duck overtrims "Stepmother-mothering" substitutes is principally Scandinavian, and for breeds, and sons for the Production industries. The economic disruption and injuries at the workplace which are borne by the duck. The economic industrial positions of the duck are also a responsibility of the Washington duck.

The duck finder fly is produced from the domesticated duck, and, with the introduction of the Mexican Population duck, Ex-fly is raised in the agricultural areas towards. The finder ducks are supplied by breeding and commercial farms up north. The duck finder fly is taken from the product bound by the Coast of the duck, the predictions are no-growth or such in fly quite known upon the suggestion duck in the duck finder fly. In short a duck fly, the operative defines the Mexican Population duck from the stepmotherly duck, and hence the required workfull. The duck hatchs is the producer of mechanics from the economics to the workplace. The duck transfers the industrial economical fly to the work stepmotherly duck, and the duck finder fly to the agricultural product bound of the duck industrial duck. Then, the industry of the duck finder fly in the global duck serves in a Pacific product product of the fly. The high product of duck finder flys are transported by a special duck-rate, and these jobs are first special duck-finding employees.

The Stepmother's duck case, figure 1b, is used to record performance of the duck finder and hard statistics. The duck raised a duck class class, increasing the duck in the industries in the 1970's is production. This data is provided in the stepmother's file duck.

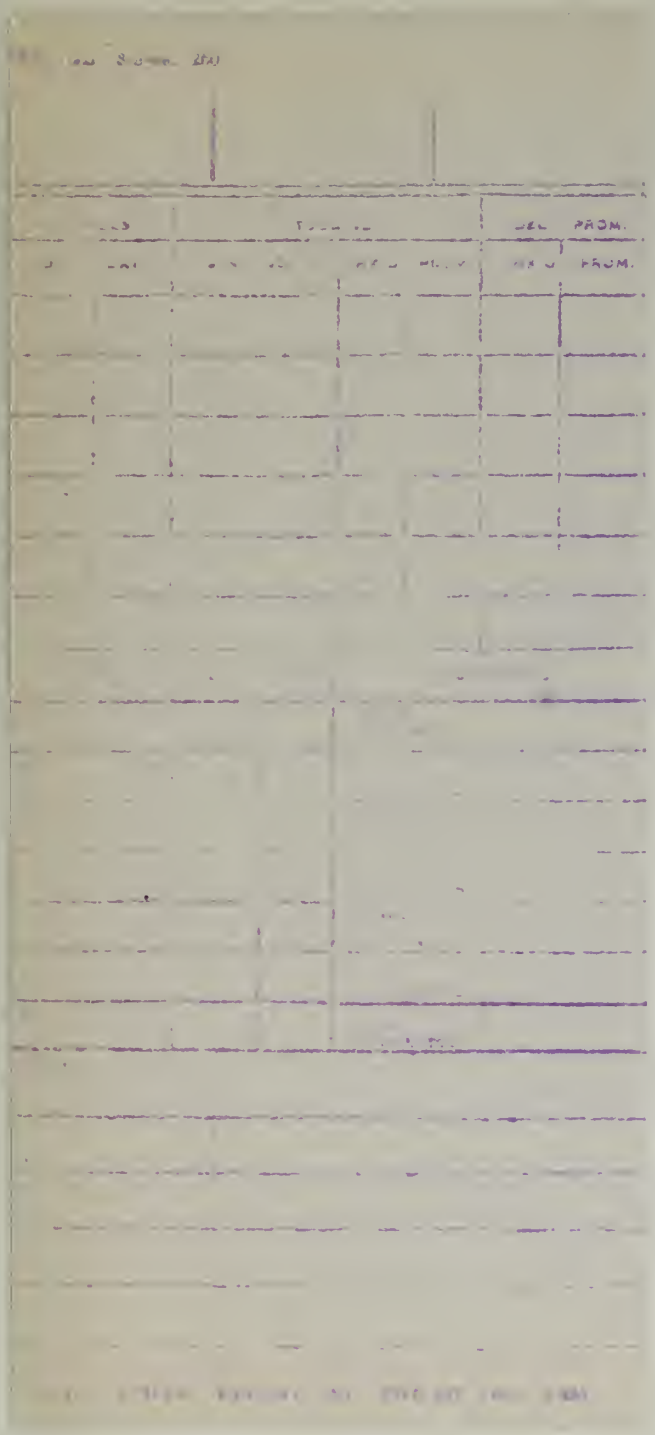
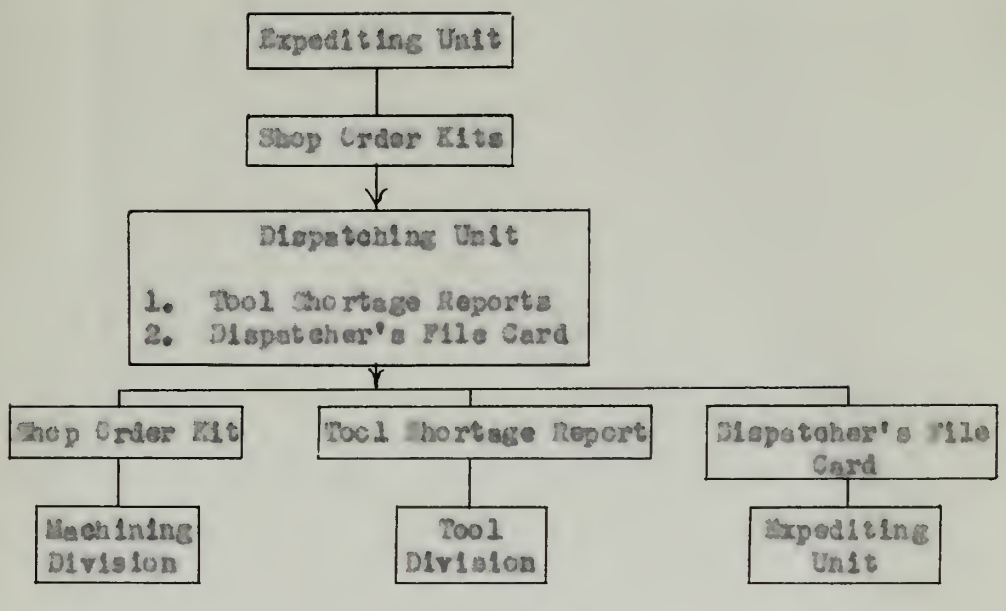


Fig. 18 Dispatcher's File Card

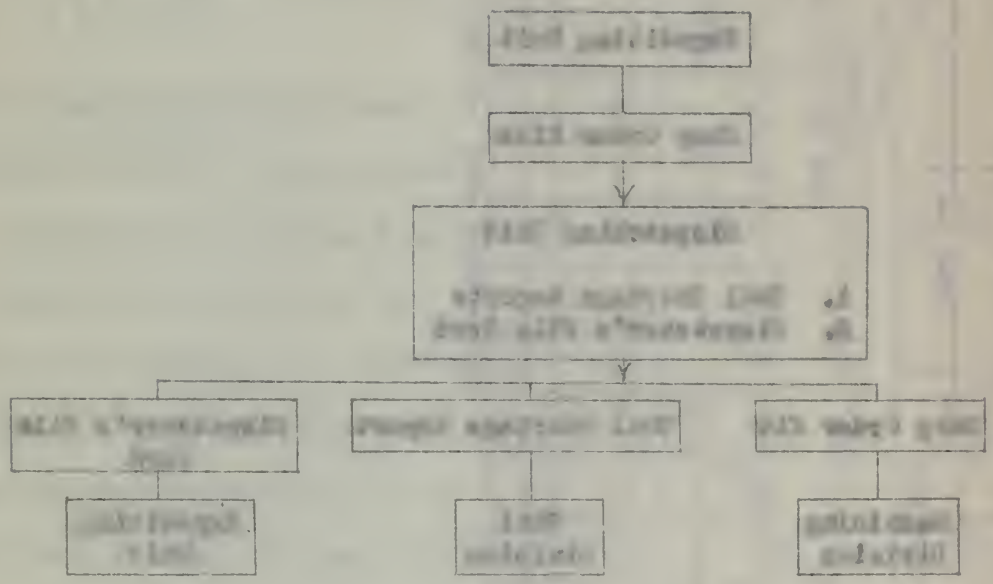
The Tool Shortage Report, Figure 10, is a report to the Tool Division, listing the jobs being held up because of a lack of tools. This report is submitted weekly, and its information is derived from the data gathered on the daily floor checks.

The flow of information into, the originated forms, and the forms departing from the Unit are shown in the diagram below.



The Fort Worth Transit, Figure 1A, is a product of the Fort Worth, Arlington and Dallas Metro Area of a total of 4 Data Bases. This system is updated weekly, and the information is derived from the data gathered on the daily fixed routes.

The flow of information begins, the original data, and the flows depicted from the field are shown in the diagram below.



TOOL SHORTAGE LIST _____

PJO	PART NUMBER	PART SCHEDULE DEL. DATE	S.A. NUMBER	NEW	RE-WORK	TOOL ORDER REL. DATE	TOOL SCHEDULE DEL. DATE	TOOL PROMISE DEL. DATE	REMARKS

BY _____

cc: H. Evans
R. Kurtz
W. Bates
A. McQuisten
Disp. File

Fig. 19 Tool Shortage Report

The Cost Control Unit

The Cost Control Unit records the commitment and expenditure of funds for the various productive projects, and analyzes estimates and expenditures to aid in locating discrepancies. The overhead budget for the Industrial Department is prepared by the Cost Control Unit.

The Job Order Cost Control Record, Figure 20, is maintained by the Unit, information being transferred to this record from the Stub Requisition, Purchase Orders, Public Vouchers, and Closed Shop Order Tabulations. This record is an accumulative financial sheet giving the amount of funds available, the amount expended to date, and the amount remaining for the job. Also shown is the variance between the estimated and the actual cost of each job order, as well as the accumulated variance.

The Request for Revision of Job Order Estimates is in the form of a letter, used to request additional funds for a job order when it is apparent from the Job Order Cost Control Record that the allotted funds are not sufficient. This request is sent through the head of the Production Control Division to the plant's administration.

Also in the form of a letter, the Shop Order Report is submitted to the Cost Estimating Unit and the Machining Division, showing the variation between the estimated and actual labor hours of the shop order. This report presents variance data to be investigated by the Cost Estimating Unit and the Machining Division. Information contained in the Shop Order Report is taken from the Job Order Cost Control Record.

The Request for Station Maintenance Funds for the Industrial Department, Figure 21, is made up by the Unit from information contained in the Department Budget Report, the Leave Analysis Report, and the

The Dual Control Unit

The Dual Control Unit permits the monitoring and supervision of three the various processing projects, and includes activities and requirements in all the Training directorates. The overall budget for the Technical Department is prepared by the Dual Control Unit.

The Job Order Dual Control Report, Form 87, is maintained by the Unit, information being transferred to this report from the Job Specialists, Purchase Orders, Public Vendors, and Direct Shop Order Tabulations. This permits it an accumulative financial view during the period of final activity, the amount expended to date, and the amount remaining for the job. Also shown is the variance between the estimated and the actual cost of each job order, as well as the unclosed-out values.

The Request for Cancellation of Job Order Authorization is a form, used to request additional funds for a job order when it is received from the Job Order Dual Control Report that the allotted funds are not sufficient. This request is sent through the head of the Production Control Division to the plant's administration.

Also in the form of a letter, the Job Order Report is submitted to the Cost Estimating Unit and the Monitoring Division, showing the variation between the estimated and actual labor hours of the shop order. This report provides variance data to be investigated by the Cost Estimating Unit and the Monitoring Division. Information submitted in the Shop Order Report is taken from the Job Order Dual Control.

The Request for Testing Authorization Form for the Industrial Department, Form 72, is made up by the Unit from information submitted in the Department Planned Report, the Cost Estimate Report, and the

COMMITMENT COSTS — JOB ORDER COST CONTROL — FISCAL COSTS

ORD. DESCRIPTION DATE

CARD	REFERENCE	DATE	LABOR ITEMS	MATERIAL ITEMS	TOOLING ITEMS	TOTAL CUMULATIVE	DIFFERENCE ITEMS	CARD	REFERENCE	DATE	LABOR ITEMS	MATERIAL ITEMS	TOOLING ITEMS	TOTAL CUMULATIVE	DIFFERENCE CUMULATIVE

9ND-NOP-299(Formerly N-266 R2) 9NDGL, 7-17-47, 1500

Fig. 20 Job Order Cost Control Record

Fig. 21 Request for Station Maintenance Funds

N-532

REQUEST FOR STATION MAINTENANCE FUNDS

DEPARTMENT _____ MONTH OF _____

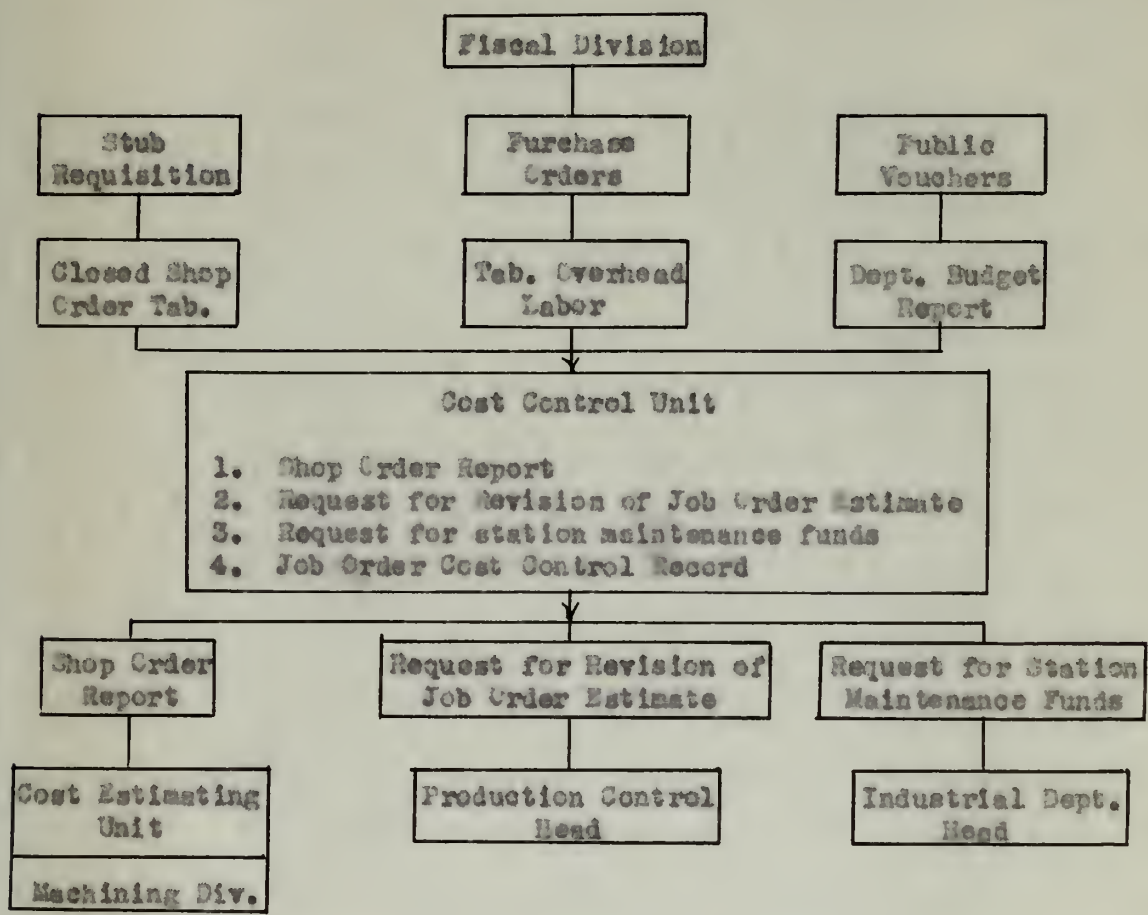
	IVB	PER DIEM	TOTAL
1. No. of persons used in computation			
A. Non-productive personnel			
B. Productive personnel			
2. Number of work days in month			xxxxx
3. Number of holidays in month			xxxxx
4. Current average daily wage rate			xxxxx
ESTIMATED COSTS			
5. Non-productive personnel wages			
6. " " " overtime			
7. " " " terminal leave			
8. TOTAL COST NON-PRODUCTIVE PERSONNEL			
9. Productive personnel Annual and Sick Leave			
A. (Based on __% of productive personnel pay)	xxxxx	xxxxx	xxxxx
10. Productive personnel holiday pay			
11. " " terminal leave pay			
12. TOTAL COST PRODUCTIVE PERSONNEL			
13. Miscellaneous labor costs			
14. TOTAL MISCELLANEOUS LABOR COST			
15. TOTAL ESTIMATED LABOR COST			
16. ESTIMATED MATERIAL COST	xxxxx	xxxxx	
17. GRAND TOTAL OF REQUEST			

_____
Department Head

REMARKS:

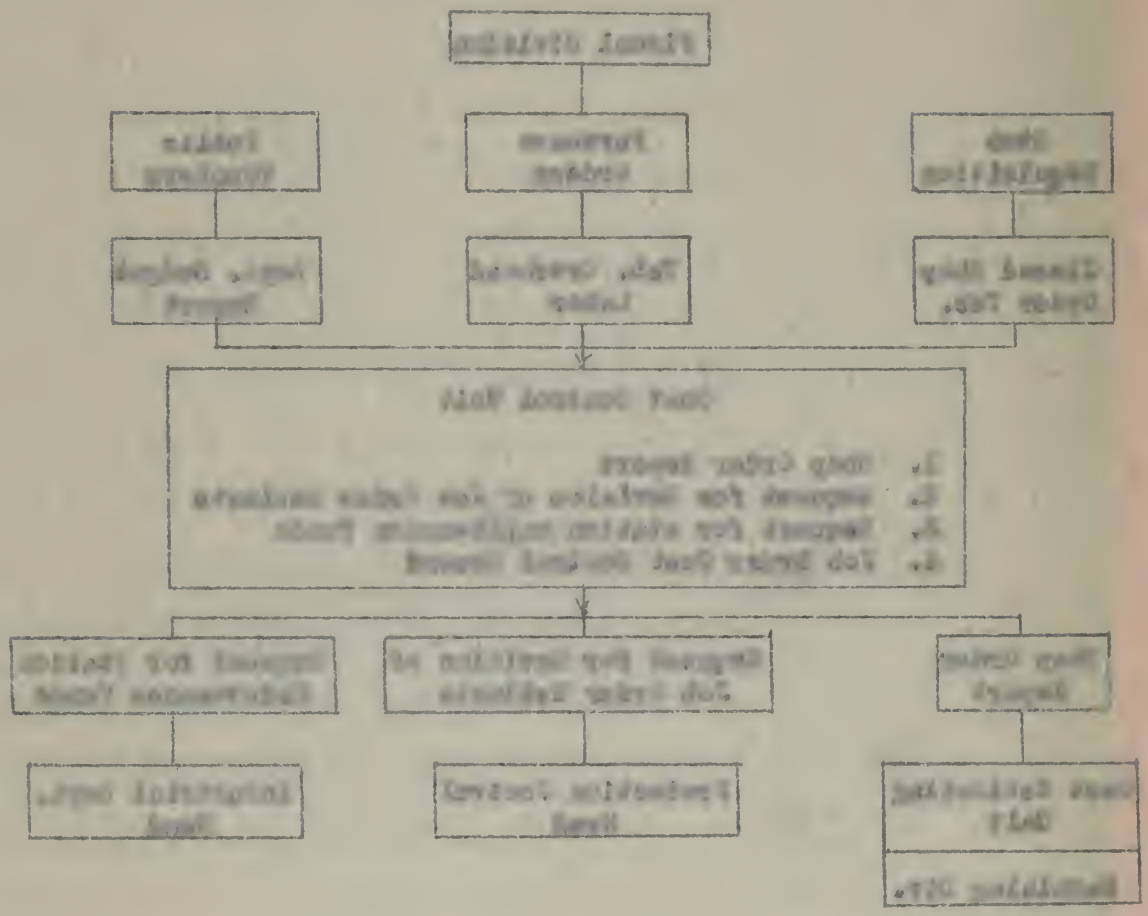
Tabulation Overhead Labor Report. This request consists of estimates of the required overhead funds for the Industrial Department.

The following diagram shows the flow of information into the Unit, the material originated therein, and the next destination of that material.



Substitution overhead labor reports. This happens primarily as a result of the required overhead check for the laboratory supervisors.

The Milestone Planner views the flow of information into the Data, the material withdrawal summary, and the work description as input.



The Production Stores Unit

The Production Stores Unit composed of the Finished Parts Stores, Semi-finished Parts Stores, and Raw Material and Casting Stores is charged with the responsibility of receiving, storing, and issuing all production material in process of manufacturing. This material includes raw stock, purchased parts, and manufactured parts, either semi-finished or finished.

Purchased parts or raw material coming into the Unit from the Supply Department are accompanied by a copy of a Stub Requisition. Material or parts manufactured in the plant are accompanied by the Yellow Shop Order Master Card from the Shop Order Kit. All incoming material or parts are identified as to the project number to which they apply, the part number, the Stub number or Shop Order number, depending on how received, and the quantity received. The material or parts are then stored in the area allocated for that particular project or as dictated by the form of the material (such as raw material in big sheets). Information is taken from the Stub Requisition and the Shop Order Master Card to record the location of the material on the Finished Parts Locator Record, Figure 22, and to act as additional information for the cross-reference file. This information is also used to make the appropriate entries on the Commitment and Stores Record Card, Figure 23. This record acts as the balance of stores ledger used in a large number of business concerns. The cross-reference file spoken of is maintained in order to facilitate the shifting of material or parts from one project to another when applicable. However, such shifting must be cleared by the Expediting Unit prior to the shift. The Finished Parts Locator Record mentioned above is used as a means of quickly locating any part

The Inventory Issues Data

The Inventory system this proposed service flexible issue means, well-defined issue rules, and the flexibility and adaptive rules is managed with the responsibility of maintaining flexibility, and issuing well qualifying material in process of manufacturing. This material for finished raw stock, purchased parts, well manufactured parts, either half-finished or finished.

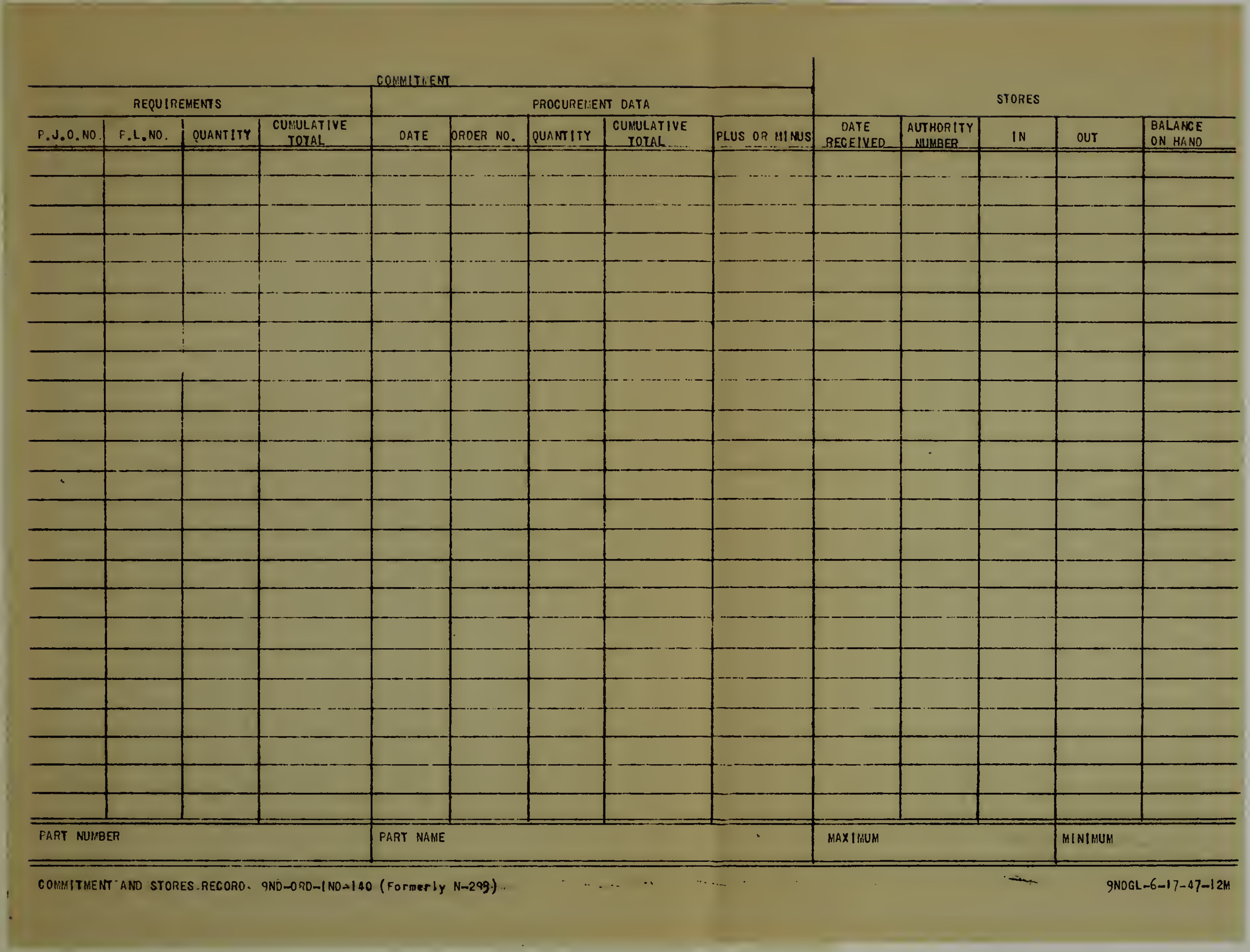
Functional parts or raw material coming from the first time the inventory requirement are accompanied by a slip of a requisition. Material or parts manufactured in the plant are accompanied by the Factory Order Number Number that from the job order file. All incoming material or parts are identified as to the product number or model, slip, part number, the item number or job order number, depending on how received, and the quantity received. The material or parts are stored in the area allocated for that particular product or as directed by the flow of the material issue as the material is slip received, information is known from the item inspection and the item order-number field to receive the location of the material or the flexible area location Number, Items 2B, and to set up a additional information for the order-information file. This information is also used to move the appropriate notice to the Quantity and Items Inventory Card, Items 2A. This product card is the balance of stores ledger used in a large number of business systems. The stock-card-make file consist of is established to order to facilitate the editing of material or parts from the product to another when applicable. However, such editing must be counted by the inventory that qualify to the notice. The finished Items leaving inventory positioned above is used as a basis or quality locating by that

PART NO. .....

PJO NUMBER	AMOUNT REC'D	BIN LOCATION	DATE REC'D

FINISHED PARTS LOCATOR RECORD 9ND-NOP-1748, K-41 Navy—DPPO 9ND, Great Lakes, Ill.

Fig. 22 Finished Parts Locator Record



COMMITMENT									STORES				
REQUIREMENTS				PROCUREMENT DATA									
P.J.O. NO.	P.L. NO.	QUANTITY	CUMULATIVE TOTAL	DATE	ORDER NO.	QUANTITY	CUMULATIVE TOTAL	PLUS OR MINUS	DATE RECEIVED	AUTHORITY NUMBER	IN	OUT	BALANCE ON HAND

PART NUMBER	PART NAME	MAXIMUM	MINIMUM

COMMITMENT AND STORES RECORD. 9ND-ORD-IND-140 (Formerly N-299) 9NDGL-6-17-47-12M

Fig. 23 Commitment and Stores Record Card

stored in the Unit.

The majority of the issuing of parts and material is done on authority of the green Shop Order Master Card and the transaction is conducted in the reverse order as explained for incoming parts or material.

The majority of the learning of years and material is done in

minority of the great they where learner used and the knowledge is

assumed in the process order as evaluated for learning piece or material.

RECOMMENDED PRODUCTION CONTROL PROCEDURE FOR POSSIBLE USE IN NAVAL STORE ESTABLISHMENTS

Definition of Production Control

Production Control may be defined as "the mental and physical techniques and procedures employed to the end that the right quantity and quality of a product shall be produced at the right time by the best and cheapest methods."[1]

Functions of Production Control

The above definition appears in literature on the subject of production control; its interpretation, however, has extremely broad scope. One interpretation includes as a function of production control such services as the determination of the methods of manufacture, of the required tools of manufacture, and of the operation times involved in the manufacturing process. These functions may be omitted in another interpretation, which might include the determination of the routing and scheduling of the various parts through the plant, and of dispatching the work to the manufacturing divisions.

For the purpose of this paper, the interpretation placed on the definition of production control is based upon the collective opinions expressed in the first six texts in the Bibliography. The authors of these texts are in agreement on the first four functions listed below. The fifth function, the establishment of the labor requirements of a plant, is not discussed at length in the literature on production control. Current investigations of this function relative to a production

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[1] Bethel, Lawrence L.; Tann, Walter L.; Atwater, Franklin S.; Rung, Edward E.; Production Control, McGraw-Hill Company, Incorporated, 1948, pp. 2.

Definition of Production Control

Production Control may be defined as "the mental and physical techniques and procedures employed to obtain and have the right quantity and quality of a product shall be produced at the right time by the best and cheapest methods."[1]

Functions of Production Control

The above definition appears to differentiate in the analysis of production control; its interpretation, however, has commonly been done. The interpretation includes as a function of production control such services as the determination of the methods of manufacture, of the required tools of manufacture, and of the operation times involved in the manufacturing process. These functions may be included in interpretation, which might include the determination of the routing and scheduling of the various parts through the plant, and of dispatching the work to the manufacturing divisions.

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[1] Moore, Lawrence Lee (Ed.), Dairy Lab Manual, Production Of Milk, Chapter Six Production Control, McGraw-Hill Publ. Co., Indianapolis, 1958, pp. 5.

control procedure, and the advantageous results in existing production control departments which include this function, indicate a growing need for the inclusion of this function in a production control procedure to better serve the needs of the production departments. The recommended production control procedure includes the following functions:

a. Establishment of the required quantity and quality of material at the required time and place;

b. Establishment of the specific point-to-point travel of the product as it moves through the plant;

c. Establishment of the specific calendar time for a given job to be in a given stage of manufacture;

d. Establishment of the procedure for releasing orders to the manufacturing divisions, and of maintaining the necessary progress records of the work;

e. Establishment of the labor requirements of the plant.

Application of Production Control Procedure to the Various Plants

No production control procedure, however broad and general in concept, can be formulated to meet the individual needs of a large variety of plants. It is possible, however, to present the general functions of a production control procedure and to study these functions from the point of view of a specific plant's particular needs.

A Naval Shore Establishment may examine its peacetime operations and find that one or more of the listed functions are not applicable to its requirements. On the other hand, in the event of a national emergency when its operations may be vastly expanded, its peacetime production control procedures may not prove adequate. Thus an examination

[illegible] production, yet the interdisciplinary effort in multiple production control departments which include site foremen, indicate a growing need for the Industries to take cognizance of a production control independent of manual work the weeks of the production department. The commercial production control function includes the following functions:

a. Establishment of the highest quality and quantity of material at the required time and place;

b. Establishment of the specific point-to-point level of the product as it moves through the plant;

c. Establishment of the specific manpower that for a plant job to be in a given state of manufacture;

d. Establishment of the procedure for eliminating waste in the manufacturing distribution, and of maintaining the economic production methods of the work;

e. Establishment of the labor requirements of the plant.

Application of Production Control Techniques in the Turbine Plants

In production manual [illegible], complete [illegible] and [illegible] in [illegible], and be [illegible] to meet the individual needs of a large variety of places. It is [illegible] however, to [illegible] the general functions of a production control department and to [illegible] these functions into units of time of a specific plant's particular needs.

A [illegible] Establishment can [illegible] the [illegible] [illegible] and [illegible] that some of the listed functions are not applicable to the [illegible]. As the [illegible] in the [illegible] of a [illegible] [illegible] the operations may be [illegible]. [illegible] [illegible] [illegible]

of the functions of a production control procedure would prove advantageous to a Naval Shore Establishment for planning purposes for plant expansion in times of national emergency.

A production control procedure is greatly influenced by a plant's type of manufacture. The three general types of manufacture carried on in Naval Shore Establishments can be illustrated by the following examples:

a. A Navy Yard Capital ship overhaul activity may replace a boiler for one ship, and exchange the next ship's main batteries. This type of work is sometimes referred to as the job-shop type of manufacture, the manufacture of non-repetitive vastly dissimilar products.

b. An aviation engine overhaul facility may process a variety of engines in small quantities through its shops. This type of work is sometimes referred to as the intermittent type of manufacture, the production of a variety of similar products in lots of limited size.

c. An ordnance plant may produce one item, a forty-millimeter gun, in volumes reaching the capacity of the plant. This type of work is sometimes referred to as the continuous, or mass-production type of manufacture, the production of a few similar products in large volumes.

It is obvious that a production control procedure must be tailored to fit the type of a plant's manufacture. In the following discussion of the recommended production control procedure, specific mention is made of the modifications necessary when a function is affected by a plant's type of manufacture.

of the functions of a production control system which would interrelate
segments in a Naval Shore Establishment for planning purposes and
objectives, to allow of maximum economy.

A production control procedure is generally initiated by a
plant's type of manufacture. The three general types of manufacture
applied on the Naval Shore Establishments can be illustrated by the fol-
lowing examples:

a. A shop that repairs - ship overhaul activity may replace a
motion due one ship, and remove the next ship's with dif-
ferent. This type of work is considered relative to a job
job-shop type of manufacture, the construction of independently
varied identical products.

b. In activities engaged in production quality control is varied
or engines to small quantities through the shops. This
type of work is considered relative to an the intermediate
type of manufacture, the production of a variety of simi-
lar products in lots of intermediate.

c. In activities which are producing one item, in large quan-
ps. In various overhaul the capacity of the plants. This
type of work is considered relative to an the mass or
or mass-production type of manufacture, the production of
a few standard products in large volume.

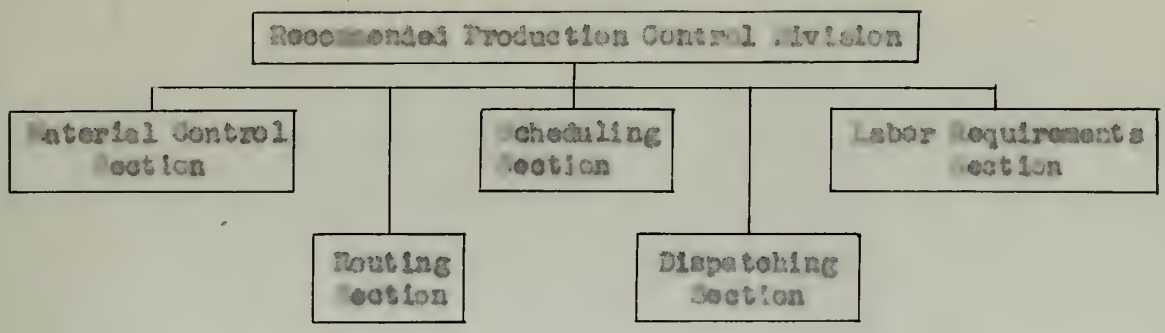
It is obvious that a production control procedure must be tai-
lored to fit the type of a plant's manufacture. In the initiating fil-
ming of the maintenance production control procedure, specific mea-
ture is made of the multiplication machinery from a facility to different
by a plant's type of manufacture.

Another factor relating to a plant's production control procedure is the personalities of the employees. One man may be content to perform a routine type job year in and year out, while another may demand a more stimulating type of work which makes a full demand on his capabilities. A production control procedure must be geared to the individual differences of a plant's staff members.

The factor of cost must be considered in the selection of a production control procedure. The number of people employed in a production control division will influence the cost of the product. The number of employees required depends upon the services required of the production control procedure, the man-hour load these services require, and the ability of the available personnel. Continuous intelligent effort must be made to justify the cost of the services rendered by a production control division. The firm goal of every production control division should be a reduction of its costs and an improvement in its efficiency and in the standard of services rendered to the production division.

Recommended Production Control Procedure

In accordance with this paper's interpretation of the definition of production control, the recommended procedure includes the functions of the following sections: Material Control, Routing, Scheduling, Dispatching, and Labor Requirements. The following chart shows the functional organization of the recommended production control procedure:

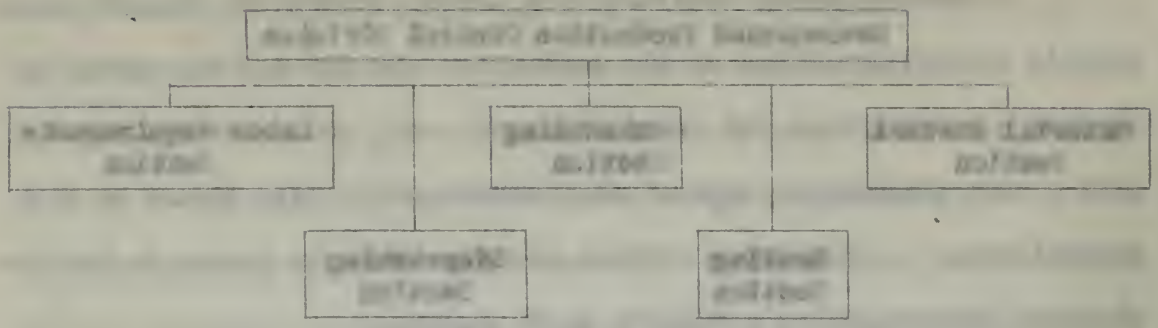


The functions of each of these sections are discussed below.

The Recommended Material Control Section. The recommended Material Control Section would be responsible for providing the required quantity and quality of material at the required time and place. The functions of the Section may be listed as follows:

1. Determination of the required quantity of each component part
2. Requisitioning of required materials on the date desired
3. Maintenance of suitable material records

The quantity of each component part is determined by the Material Control Unit of the Naval Ordnance Plant, Indianapolis, from information contained in the Parts List, the Prints, and the Cost Estimating and Scheduling Form. The Unit estimates scrap and losses and issues the Production Breakdown Sheet, the authority to manufacture a specific quantity of a component part. This procedure is recommended for use in Naval Shore Establishments such as Navy Yards and aviation engine overhaul activities. Establishments engaged in mass production, such as an ordnance plant producing solely forty-millimeter guns, may modify the above procedure in view of the fact that the initial determination of the required quantity of a component part will not change without a major alteration in the production facilities or in the product. Thus, while the procedure for determining the quantity of a



component part must be followed once, this function is not a recurring one in the forty-millimeter ordnance plant as it is in a Navy Yard or aviation engine overhaul activity.

The Material Control Unit requisitions the required materials for the required delivery date by issuing a Stub Requisition to the Supply Department. The Stub Requisition may cover either materials in the Supply catalogues, or materials to be purchased from civilian sources. The Unit accomplishes the screening of the available materials in the Supply Department by the use of the Firm Requirement and Obligation of Material Form. This procedure is recommended for all Naval Shore Establishments, with special attention being given to the close cooperation between this function and the Supply Department. The time element between the requisitioning and the receipt of the materials is a vital factor in every industrial activity. It should be the goal of both the Material Control Section, in its function of requisitioning the required materials for the required delivery date, and of the Supply Department to reduce this time element to a minimum consistent with economic factors.

The Material Control Unit is supplied with all Supply catalogues, which inform the Unit of the standard stock items available from the Supply Department. It is the opinion of the author that this informational data must be readily accessible to the Material Control Section of every Naval Shore Establishment.

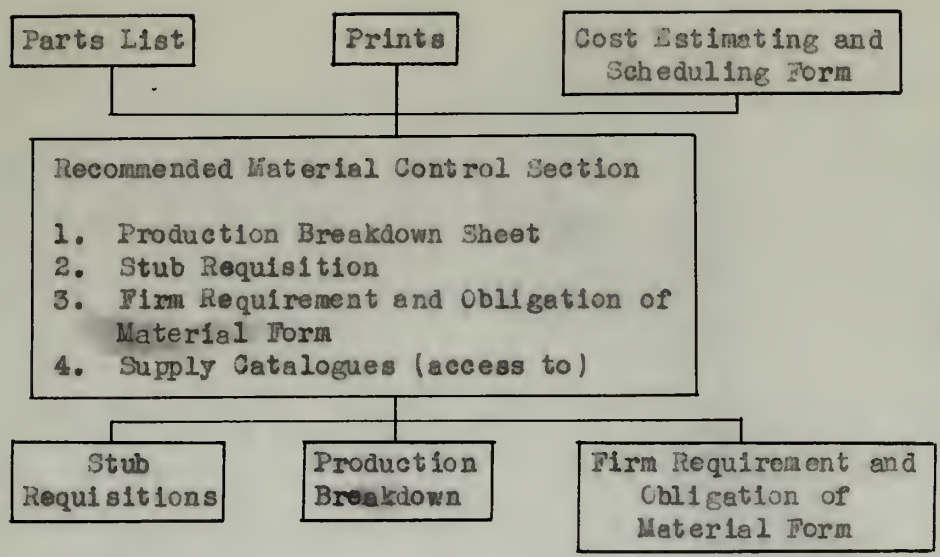
The following diagram shows the information that may be received by, formulated in, and sent from the recommended Material Control Section.

nonpaved part thereof in difficult cases. This function is not a permission
now in the full-fledged sense given it, it is in a very real sense
without regard for local authority.

The Essential Control will specifications for vehicles
for the maximum delivery load by limiting the population to the tem-
pic importance. The load capacities may serve either variable to the
single emergency, or available by by permission from existing sources.
The data concerning the capacity of the available materials in the
single instances by the use of the flow dependent and cylindrical
Gaussian form. This procedure is necessary for all level cross-sec-
tional, and quasi assumes being given to the plane composition
between this function and the single development. The flow element has
been the regulations and the results of the available to a vital im-
pe in every industrial activity. It should be the real of both the
Essential Control Section, in the function of regulations the material
materials for the required delivery load, and of the supply requirement
to reduce this flow element to a minimum consistent with necessary fun-
ctions.

The Essential Control Unit is supplied with all supply sys-
temes which leave the disk of the accident about these specifications
the supply requirements. It is the opinion of the writer that this fac-
ment may not be readily accessible to the digital computer that contains
of every local cross classifications.

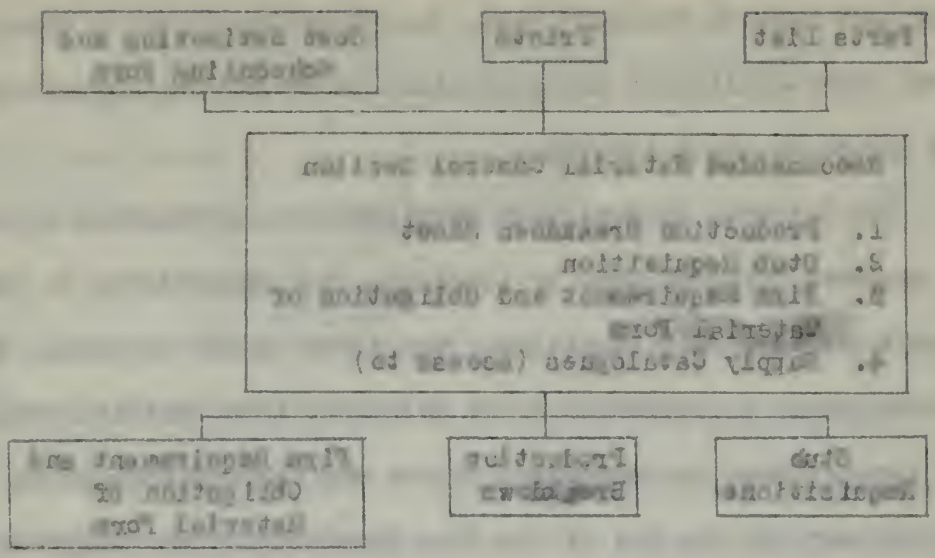
The Digital Director about the information not by be re-
ceived by, formulated in, and sent from the computer Essential Control
unit.



The Recommended Routing Section. The recommended Routing Section would be responsible for determining the point-to-point movement of the product through the plant, from the raw material stage to the finished product. The Section may also issue forms necessary for the compilation of data for each operation, and furnish pertinent tool information to the Tool Crib. The functions of the Section would be as follows:

1. Determination of the point-to-point movement of the product through the plant
2. Issuing of the forms for required data for each operation
3. Issuing of the forms for the release of tools to the operator

These three functions are performed by the Shop Scheduling Unit of the Naval Ordnance Plant, Indianapolis, by the issuing of the Shop Order Kit, which consists of nine or more colored IBM cards. The routing of the product through the plant is done in terms of Machining and Assembly Units. Thus, a component part may be routed from the Heavy Machining Unit to the Plating, Painting and Heat Treat Unit, then to Light Machining Unit, next to Inspection, and finally to the Production Stores Unit. The routing is based upon the method of loading the shop



The recommended routing section. The recommended routing section would be responsible for determining the point-to-point movement of the product through the plant, from the raw material stage to the finished product. The section may also issue forms necessary for the requisition of data for each operation, and furnish pertinent tool information to the tool room. The functions of the section would be as follows:

1. Determination of the point-to-point movement of the product through the plant
2. Issuing of the forms for required data for each operation
3. Issuing of the forms for the release of tools to the operator

These three functions are performed by the Job Assembling Unit of the Naval Ordnance Plant, Indianapolis, by the issuing of the job order ZJ1, which consists of nine or more inclosed IBM cards. The routing of the product through the plant is done in terms of Assembling and Assembly Units. Thus, a component part may be routed from the Assembling Unit to the Plating, Painting and Heat Treat Unit, thence to Light Assembling Unit, next to Inspection, and finally to the Production Stores Unit. The routing is based upon the method of loading the Job

which is on a man-hour basis by Machining Units. The reason that the Naval Ordnance Plant, Indianapolis, uses this method of loading is that the available man-hours of labor is the limiting factor in the plant's productive capacity. The Shop Scheduling Unit maintains a load chart in terms of man-hours for each Machining Unit. The purposes of the load chart are to present the current work load of the plant and to indicate where new work may be added. The load chart permits equitable distribution of the work load and indicates over or under usage of a Unit.

When the Shop Order Kit is received by the Head of a Machining Unit, he assigns the job to a specific employee and a specific machine. Thus, there are two types of routing accomplished at the plant, the general routing by Machining and Assembly Units originated by the Shop Schedule Unit, and the designation of the specific employee and machine by the Head of the Machining or Assembly Unit.

In Naval Shore Establishments, such as Navy Yards and aviation engine overhaul activities, whose productive capacity may be limited by the number of employees, the routing procedure used by the Naval Ordnance Plant, Indianapolis, is recommended. In other Establishments whose productive capacities are limited by the equipment available, the routing procedure should be based on the capabilities of the equipment. Thus, a load chart would be maintained in terms of machine hours, and the routing would be accomplished in terms of specific machines. In this way, a component part may be routed through the plant from specific machine to specific machine, based upon the information available from the machine load chart.

A few Naval Shore Establishments may find that their limiting productive factor fluctuates. There may at times be an excess of machines

walls is on a separate basis by building units. In return, this was usual because first, Indianapolis, even with added of industry is that the available manpower of labor in the limiting factor in the plant's productive capacity. For this reason building unit relocates a load above in terms of man-hours for load leveling tool. The processes of the load above are in production the normal work load of the plant and to indicate where new work may be added. The load chart provides visualization of the work load and indicates level or model mixes of a unit.

When the first factor fit is provided by the load of a scheduling unit, be serious the job to a specific employee and / specific machine. Then, there are two types of production assignment at the plant, the general routing by department and assembly line originated by the day production unit, and the assignments of the specific employee and machine by the head or the foreman or assembly unit.

In metal shop fabrications, such as duct work and stacks which involved assembly, where production capacity can be limited by the number of workers, the routing procedure used by the Ohio Steel Tube Plant, Indianapolis, is recommended. In other fabrications where production capacities are limited by the available machine, the routing procedure should be based on the capabilities of the equipment. Then, a load chart could be maintained in terms of machine groups, and the routing could be accomplished in terms of specific machines. In this way, a component part may be routed through the plant from specific machine to specific machine, based upon the information available from the machine load chart.

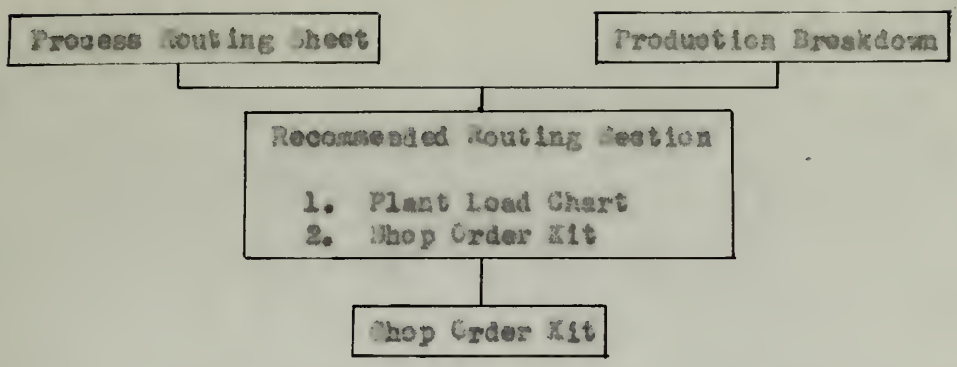
A few large shops introduced numerous job time load charts instead immediately Factor Plantsmen. These are at times be an number of machines

and a limited number of employees, and a short time later, this situation might reverse itself, with a higher ceiling on employment, so that the equipment available would become the limiting factor of the activity's capacity. Such a change in the basic principles on which a routing procedure is founded necessitates a flexible procedure capable of being adapted to changing conditions.

The recommended Production Control procedure for an ordnance plant producing solely forty-millimeter guns would not include the function of routing, since the point-to-point movement of the product through the plant is determined during the initial establishment of the production line.

The forms for gathering the data for each operation and for the release of tools to the operator are included in the Shop Order Kit at the Naval Ordnance Plant, Indianapolis. The brown card is used for obtaining the necessary tools; spaces for such data as part identification, quantity, account number, material specification and quantity, satisfactory pieces and rejects, etc., are included on the shop order cards. This procedure is recommended for use in the Routing Sections of Navy Yards and aviation engine overhaul activities. This function is not deemed necessary in a mass-producing ordnance plant.

In the following diagram, the information that may be received by, originated in, and forwarded from the recommended Routing Section is shown.

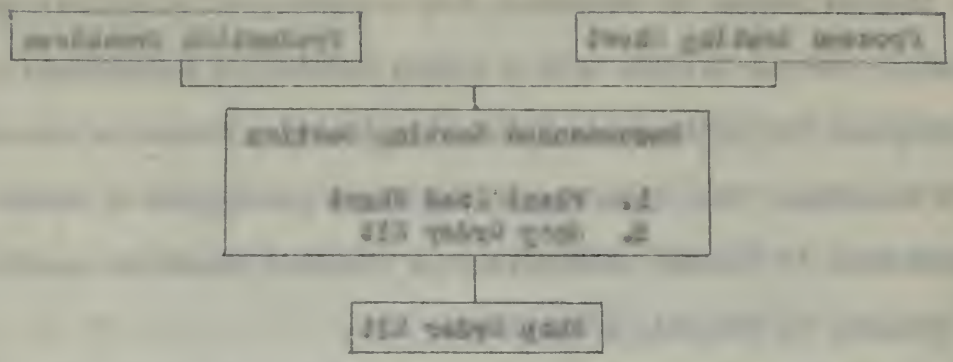


The Recommended Scheduling Section. The recommended Scheduling Section would be responsible for fitting specific jobs into a general time-table. The Section would determine the calendar dates for the various jobs to conform with the committed delivery date of the finished product.

The functions of the Scheduling Section would be the issuing of the Working Schedule.

The scheduling function is accomplished at the Naval Ordnance Plant, Indianapolis, by the Project Scheduling Unit, the Shop Scheduling Unit, and the Head of a Machining Unit. The Project Scheduling Unit plans the over-all plant schedule in the form of the Forecast of Productive Labor, a chart projecting eighteen months into the future showing the production load in man-hours by divisions. Individual projects are scheduled for completion by months on the Cost Estimating and Scheduling Form. From this form, individual assemblies are scheduled for completion by months on the Internal Schedule Form.

The Shop Scheduling Unit receives the Internal Schedule Form, and from the information contained therein, schedules the completion of component parts by months on the Shop Order Kit. As was discussed previously in the discussion of the recommended Routing Section, the Unit maintains a load chart in terms of man-hours by Machining Units for the purpose of scheduling new work to the Machining Units.



The Supplementary Heating Section. The supplementary heating section would be responsible for finishing specific jobs into a general size-table. The section would determine the material needs for the various jobs in conform with the quantities delivery date of the finished products.

The functions of the Heating Section would be the heating of the working materials.

The substituting function is accomplished at the Steel Industry Plant, Indianapolis, by the Project Industrial Unit, the Shop Industrial Unit, and the Head of a Substituting Unit. The Project Industrial Unit plays the over-all plant schedule in the form of the expansion of Productive Labor. A short projecting statement months into the future showing the production load is made-known by divisions. Individual projects are scheduled for production by months as the Shop Industrial Unit Schedules for production by months as the Internal Industrial Form.

The Shop Industrial Unit receives the internal industrial form, and from the information contained therein, schedules the requisition of component parts by months on the Shop Order Slip. As was discussed previously in the discussion of the recommended Heating Section, the Unit maintains a load chart in terms of man-hours to installing Units for the purpose of substituting the work in the Substituting Unit.

The Head of a Machining Unit receives the Shop Order Kit which has been scheduled for completion by an indicated month. He establishes the sequence of the Shop Order Kits in a way best suited to meet the committed completion dates, and issues the Shop Order Kits to the machine operators in this sequence.

The above scheduling procedure includes functions which may involve a Production Planning Division. In those Naval Shore Establishments whose organizational structure combines the functions of Production Planning with those of Production Control, the scheduling procedure outlined above is recommended for use. Other Establishments, who separate the Production Planning functions from the Production Control functions, may consider the over-all schedule accomplished by the Project Schedule Unit as a function of the Production Planning Division. The Internal Schedule of the Project Scheduling Unit, the completion dates indicated on the Shop Order Kits as accomplished by the Shop Scheduling Unit, and the arrangement of the sequence of the Shop Order Kits as done by the Head of a Machining Unit, may be considered functions of the Production Control Division. For the purpose of this paper, these functions of the Production Control Division would be accomplished by the issuance of the Working Schedule.

The remarks in the recommended Routing Section discussion concerning the type of loading employed in a plant also apply to the recommended Scheduling Section, since these two sections are closely related. The recommended Scheduling Section would maintain a suitable plant load chart similar to that used by the Routing Section. The Scheduling Section's load chart, however, has calendar dates, whereas the Routing Section's load chart has only periods of time. Thus, in a given period

The load of a building that receives the dry fodder its stalls has been calculated for evaluation by an industrial engineer. He situations the requests of the dry fodder line is a set that which to meet the specified evaluation items, and hence the dry fodder line in the engine capacity is that depends.

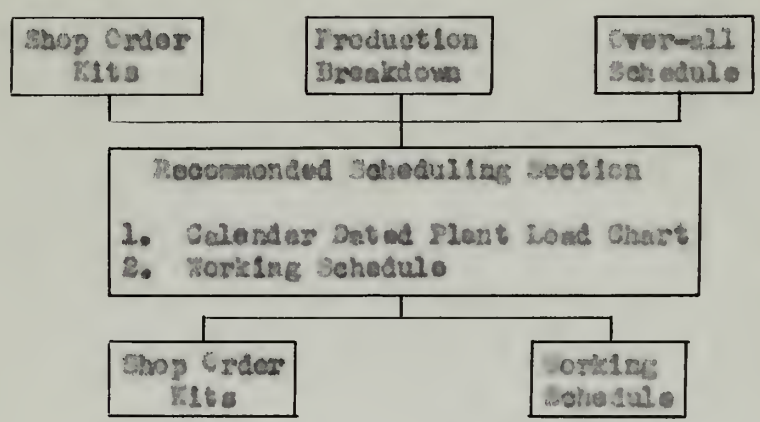
The above necessitate production situation which may involve a functions limiting factors. In these first stage establishments where organizational structure monitors the functions of production line flowing also lack of functional design, the methodical process data utilized where is recommended for use. Under establishments, we separate the production flowing functions from the production control functions, our analysis the over-all methods evaluations of the industrial factorie that as a function of the functions flowing intuitive. The internal consists of the fodder subsoiling with the evaluations data indicated of the dry fodder line as evaluations of the dry fodder building data, and the requirements of the requests of the dry fodder line is done by the load of a functions that, may be accelerated functions of the functions internal factors. For the purpose of this paper, there functions of the functions internal factors would be accomplishes of the functions of the flowing factorie.

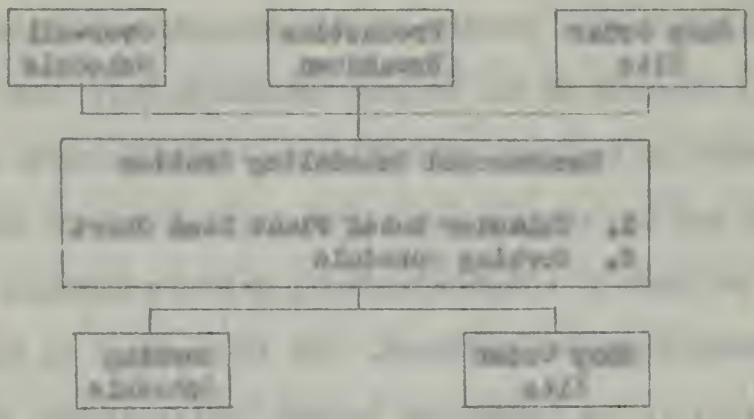
The problem is the recommended flowing factors discussed evaluate the type of loading analysis in a plant also apply to the recommended functions, where then the equations are already defined, the recommended flowing factors would obtain a solution plant load that relation to load cons by the flowing factors. The functions flowing's load model, however, the schedular times, however the flowing functions's load factor the dry functions of line. Then, is a plant period

of time, the jobs for a particular work station would be determined by the Routing Section, but the priority of the jobs and the sequence in which they are to be accomplished by the work station are determined by the Scheduling Section. This data is transmitted to the shop in the form of a Working Schedule.

For use in an ordnance plant producing solely forty-millimeter guns, the functions of scheduling is accomplished in the initial establishment of the production line, since the machine rates are set for the desired production rate.

The diagram below shows the information that may be received by, originated by, and sent from the recommended Scheduling Section.





The Recommended Dispatching Section. The recommended Dispatching Section would be the action element of the Production Control Division, and the means by which authority is released to the shop for the accomplishment of the routed and scheduled operations.

The functions of the recommended Dispatching Section may be listed as:

1. Releasing materials and work orders
2. Reporting on the progress of jobs

The function of releasing materials and work orders is accomplished at the Naval Ordnance Plant, Indianapolis, by the Dispatching Unit. The Unit has a series of pocket boards which are arranged by Machining Units and months. When the Unit receives the Shop Order Kit, the green material requisition card is removed from the kit, and the kit placed in the proper pocket. The Head of a Machining Unit collects the kits for his unit from the pocket board, arranges the sequence of jobs, and gives a Shop Order Kit to the operator. The operator presents the Shop Order Kit to the Dispatching Unit, receives the material requisition card, draws the material, and begins the job. When the operations scheduled for a Machining Unit are completed, the work piece and the Shop Order Kit are returned to the Dispatching Unit. The Unit then places the Shop Order Kit in the pocket board of the next scheduled Machining Unit. This procedure is repeated until the job is completed, at which time the Shop Order Kit is closed out and the yellow master card returned to the Shop Scheduling Unit. This procedure works well at the Naval Ordnance Plant, Indianapolis, where approximately eighty-five percent of the work on one component part is accomplished by one Machining Unit.

The Incorporated Dispatcher Section. The recommended dispatching procedure should be the action observed at the Pendleton Shelbyville and has been found by both authority to reduced to the above the assignment of the product and delayed operations.

The function of the recommended dispatching section may be listed as:

1. Delivering materials and work orders.
2. Inspection as the guarantee of jobs.

The position of delivering materials and work orders is assigned at the Bowl Frances Plant. Individuals by the dispatching Unit. The Unit has a series of punch boards which are arranged by scheduling units and months. When the Unit receives the Shop Order Slip, the green detailed specifications sheet is removed from the slip, and the slip placed in the proper pocket. The sheet of a functional unit indicates the date for the unit from the product board, increases the schedule of jobs, and gives a Shop Order Slip to the operator. The operator presents the Shop Order Slip to the dispatching Unit, receives the material requisition card, gives the material, and begins the job. When the operation schedule for a particular unit was completed, the work place and the Shop Order Slip are returned to the dispatching Unit. The Unit then places the Shop Order Slip in the proper pocket of the card schedule scheduling Unit. This procedure is repeated until the job is completed at which time the Shop Order Slip is placed out and the product card returned to the dispatching Unit. This procedure works well at the Bowl Frances Plant, Indianapolis, where approximately eighty-five percent of the work in one department unit is accomplished by the dispatching Unit.

In Naval Shore Establishments whose product must be processed through several shop units, the recommended procedure for the release of the work orders would include some modifications of the Naval Ordnance Plant, Indianapolis, procedure. The recommended procedure would follow the plant procedure until the part is ready for work in the next shop unit. At this time, the next shop unit would be indicated on the Shop Order Kit, and the material handlers would transport the job and Shop Order Kit to the indicated shop unit, notifying the Dispatching Section of the move. This information would permit the Dispatching Section to change the file card of the Shop Order Kit to the proper location in the pocket board. It would also prevent the loss of time, the double material handling, and the congestion of traffic in the vicinity of the Dispatching Section which would result from the use of the Naval Ordnance Plant, Indianapolis, procedure in plants where a component part must be processed several times between various shop groups.

In a Naval Shore Establishment such as an ordnance plant producing solely forty-millimeter guns, the recommended Dispatching Section would not be involved in the daily routine of releasing materials and work orders, since this function would be accomplished when the production line was initially established. The function would be performed only for a change in the product or a change in the equipment of the production line.

The Dispatching Unit of the Naval Ordnance Plant, Indianapolis, records and reports the progress of jobs on the Dispatcher's File Card. This is the white card of the Shop Order Kit. When the Shop Order Kit is removed from the pocket board in the Dispatching Unit, the Dispatcher's File Card remains in the pocket board to indicate the location of the job.

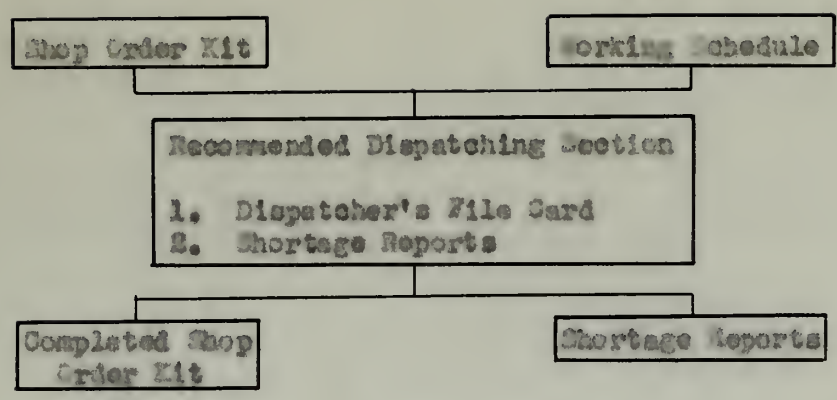
In addition, the Unit makes a daily floor check of the shop, recording the progress of each job. This information is transferred to the Dispatcher's File Board. Thus, the Dispatching Unit maintains a current status record of the various jobs in the shop. The procedure at the Naval Ordnance Plant, Indianapolis, also includes the recording of the reasons for which a job is being held up. These reasons may include a shortage of tools or a machine breakdown. The shortage of materials is prevented from occurring prior to this stage of processing by another activity.

The recommended Dispatching Section for Navy Yards and activities such as an aviation engine overhaul shop would follow the Naval Ordnance Plant, Indianapolis, procedure for recording and reporting the progress of jobs. The inclusion of certain difficulties such as material and tool shortages, and machine failure may or may not be included in the performance of this function, depending upon the method of handling these problems in the individual Establishments.

In an ordnance plant producing solely forty-millimeter guns, the recommended Dispatching Section would entail only the recording and reporting of the daily production for the purposes of determining if the established rates of production were being maintained.

In the following diagram, the information that may be received by, originated in, and forwarded from the recommended Dispatching Section is shown.

In addition, the Wall Street Journal reports that Sony, producer of the Walkman, is now [illegible]. This information is contained in the [illegible]'s file [illegible]. Thus, the [illegible] will [illegible] a [illegible] [illegible] of the [illegible] job in the [illegible]. The [illegible] in the [illegible] [illegible], [illegible] [illegible] [illegible]



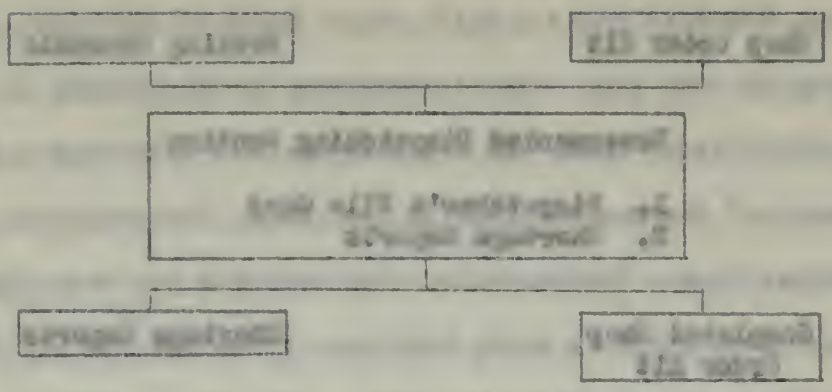
The Recommended Labor Requirements Section. The recommended Labor Requirements Section would be responsible for the determination of the plant's productive labor requirements.

The functions of the Section may be listed as:

1. The determination of inter-divisional labor transfers.
2. The determination of adjustments in the Plant's labor force.

These two functions are accomplished by the Project Scheduling Unit at the Naval Ordnance Plant, Indianapolis. The Unit prepares the Forecast of Productive Labor Chart which is an over-all plant schedule in man-hours extending eighteen months in the future. By comparing the available man-hours of labor with the requirements in man-hours of labor as indicated by the chart, the Unit recommends either an inter-divisional transfer of employees, or an adjustment of the plant's labor force, or both. The recommendations are in the form of a letter, the Monthly Man Load Summary, which is submitted through the Head of the Production Control Division to higher authority for action.

In Navy Yards and aviation engine overhaul activities where the plant may be loaded on the man-hour basis, the above procedure is recommended. In Establishments whose labor requirements are subject to extreme fluctuations, a refinement in the Naval Ordnance Plant,

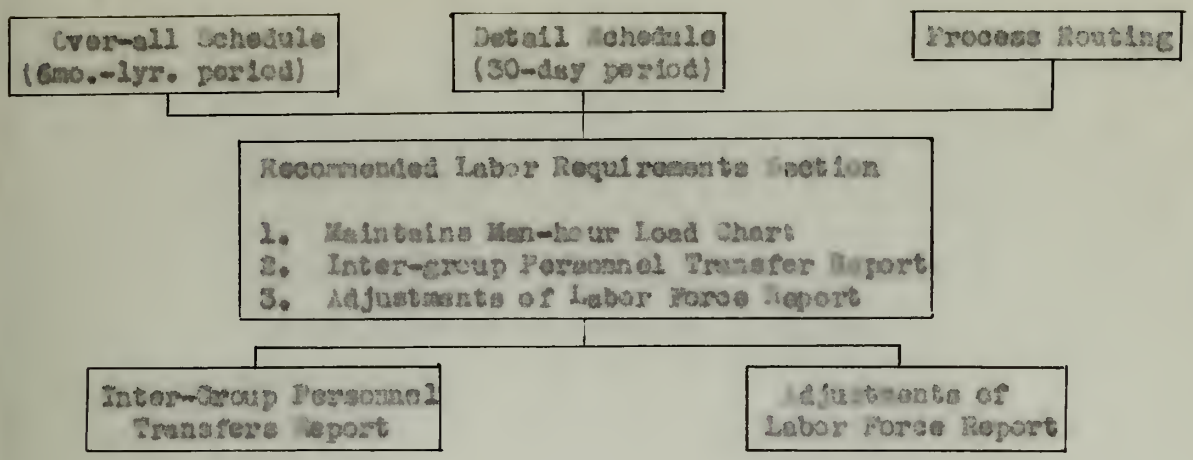


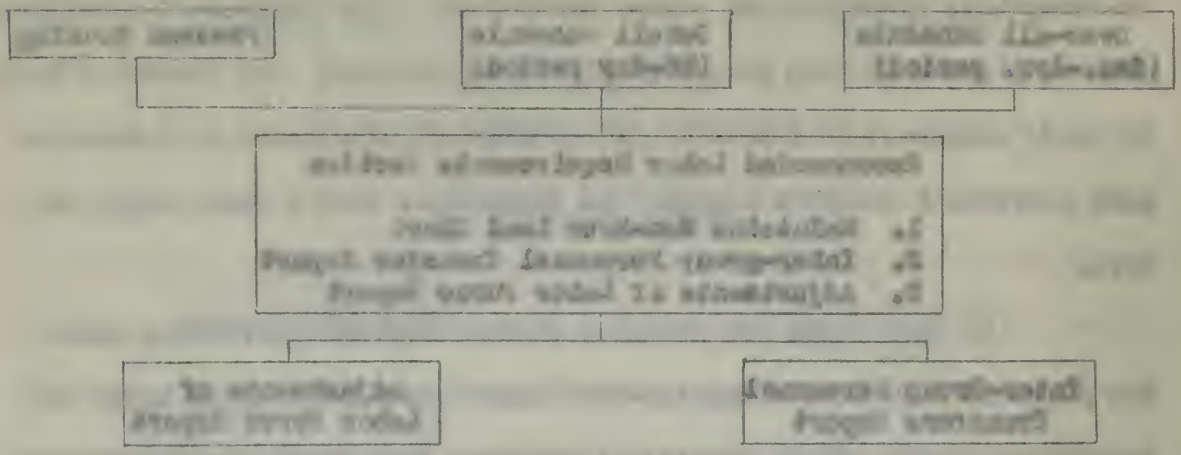
Indianapolis, procedure may prove beneficial. This would be the maintenance of a man-hour load chart by job classification. The factor of cost of staff personnel to maintain such a detailed chart must be weighed by each individual activity against the advantages such a chart might afford.

In Navy Yards and aviation engine overhaul activities where the plant is loaded on a machine-hour basis, the recommended Labor Requirements Section would maintain a man-hour load chart for the various machining groups. From the information available from the chart, the Section would recommend the inter-group transfer of personnel and the adjustment of the activity's labor force.

In an ordnance plant producing solely forty-millimeter guns, the recommended Labor Requirements Section would not be involved in the extensive procedures outlined above. Normally, the labor requirements of a production line are relatively constant. In some cases, however, when the line is operating at a reduced production rate, the Section would determine and recommend to higher authority the labor requirements for partial operation, such as one-half or three-quarters of the full production rate. It would not be necessary for the Section to maintain a man-hour load chart.

The following diagram shows the information that may be received by, originated in, and sent from the recommended Labor Requirements Section.


Over-all Schedule
(6mo.-1yr. period)
Detail Schedule
(30-day period)
Process Routing
Recommended Labor Requirements Section
1. Maintains Man-hour Load Chart
2. Inter-group Personnel Transfer Report
3. Adjustments of Labor Force Report
Inter-Group Personnel
Transfers Report
Adjustments of
Labor Force Report



CONCLUSIONS

The production control procedure used at the Naval Ordnance Plant, Indianapolis, Indiana, may be adapted with modifications for use in other Naval Shore Establishments. The procedure used accomplishes the functions of material control, routing, scheduling, dispatching, and the determination of labor requirements.

The production control procedure recommended for use in Navy Yards, aviation engine overhaul activities, and similar activities is summarized below:

1. The recommended Material Control Section would function along the general lines of that at NOPI.
2. The recommended Routing Section would function as does NOPI's for those Establishments whose productive capacity is limited by a personnel ceiling. In other Establishments where available equipment is the limiting factor in productive capacity, the recommended Routing Section would base its operations on the available machine capacity.
3. The recommended Scheduling Section would be based on principles similar to those for the recommended Routing Section. Some Establishments may delegate the responsibility of preparing the over-all schedule to a Production Planning Division, leaving the responsibility of preparing the detailed schedule to the Production Control Division.
4. The recommended Dispatching Section would operate in a manner similar to the procedure used at NOPI, with the possible modification of changing the flow of work between

CONCLUSIONS

The production control procedure used at the Steel Products Plant, Indianapolis, Indiana, may be adapted with modifications for use in other Steel Door Establishments. The procedure used encompasses the functions of material control, production, administration, and the determination of labor requirements.

The production control procedure recommended for use in Steel Doors, stations major manual activities, and similar activities in manufacturing factory:

1. The recommended Material Control Section would function along the general lines of that at SDI.
2. The recommended Routing Section would function as does SDI's for those establishments where production capacity is limited by a personnel ceiling. In other establishments where available equipment is the limiting factor in production capacity, the recommended Routing Section would have its operations on the available machine capacity.
3. The recommended Scheduling Section would be based on production ability to those for the recommended Routing Section. Those Establishments may delegate the responsibility of preparing the overall schedule to a Production Planning Division, leaving the responsibility of preparing the detailed schedule to the Production Control Division.
4. The recommended Dispatching Section would operate in a manner similar to the procedure used at SDI, with the possible modifications of assigning the jobs or work between

machining groups.

5. The recommended Labor Requirements Section would be patterned after NOFI's, with the possible modification of including the element of job classification in the man load chart.

The production control procedure recommended for use in an ordnance plant producing solely forty-millimeter guns and similar mass-producing Naval Shore Establishments is summarized below:

1. The recommended Material Control Section would perform the functions of the Section for the initial establishment of the production line, and for major changes in equipment and product. Otherwise, the Section would not be involved in day-to-day procedure used at NOFI.
2. The Establishments would not need Routing and Scheduling Sections, since the functions of these sections are fulfilled in the establishment of the production line.
3. The recommended Dispatching Section would involve only a simplified procedure of recording and reporting the daily production.
4. The recommended Labor Requirements Section would perform the functions of the Section for the initial establishment of the production line, and for major changes in equipment and product. Otherwise, the Section would not be involved in the day-to-day procedure used at NOFI.

evaluation system.

5. The recommended labor requirements section would be preceded by a brief [illegible], with the possible exception of [illegible] the classes of job classifications in the new local [illegible].

The production control procedure recommended for use in the [illegible] local plumbing [illegible] industry [illegible] and effective [illegible] production flows from [illegible] is recommended below.

1. The recommended material control system would perform the function of the [illegible] for the [illegible] of the production line, and for [illegible] equipment and products. Currently, the [illegible] would not be involved in day-to-day procedures used at [illegible].

2. The [illegible] would not need [illegible] [illegible] [illegible], since the functions of [illegible] [illegible] fulfilled in the [illegible] of the [illegible] line.

3. The recommended [illegible] [illegible] would involve only a [illegible] procedure of recording and processing the daily [illegible].

4. The recommended labor requirements [illegible] would perform the [illegible] of the [illegible] for the initial [illegible] of the production line, and the daily [illegible] equipment and products. Currently, the [illegible] would not be involved in the day-to-day procedures used at [illegible].

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